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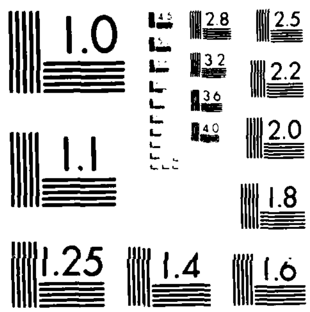

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MODELS FOR BALLISTIC WIND MEASUREMENT ERROR ANALYSIS VOLUME II: USERS' MANUAL

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By

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Under Contract DAAD07-79-C-0008

Contract Monitor: Bernard F. Engebos

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US Army Electronics Research and Development Command
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Three models for ballistic wind measurement error analysis are discussed. These models, which were originally formulated by Donald M. Swingle, are named RAWIN, RADAR, and NAVAID. Each is applicable to a different type of meteorological acquisition system. RAWIN models the case of a balloon-borne radiosonde and ground based set for radiodirection finding and telemetry data reception. RADAR models the case in which a ground based radar

set tracks an ascending balloon. NAVAID models the case in which radionavigation techniques are used to determine radiosonde position.

Expressions for the variance in the East and North components of ballistic wind are obtained in terms of bias and random measurement errors and other parameters. Also, an average error quantity called the component velocity variance is defined.

In volume I each model is described and the necessary computational expressions are derived. In volume II the utilization of the associated computer programs on the UNIVAC 1108 at White Sands Missile Range is described.

ACKNOWLEDGEMENTS

The measurement error analysis models discussed in this report were originally formulated by Donald M. Swingle for use in cost operational effectiveness analyses of competitive meteorological data acquisition systems. Numerous discussions with him were helpful in the development of this presentation.

Bernard F. Engebos, Walter B. Miller, and Abel J. Blanco, all of the U.S. Army Atmospheric Sciences Laboratory, contributed useful comments and suggestions concerning this work. It should be noted, however, that the views and opinions expressed herein do not necessarily represent those of any of these individuals.

The author also wishes to acknowledge Douglas Anderson, who did the majority of the computer programming. William Shuster also helped in this regard.

TABLE OF CONTENTS

1.0 INTRODUCTION

The ballistic wind error analysis models, RAWIN, RADAR, and NAVAID, are formulated in Volume I of this report. The reader is referred to Volume I for a general discussion of each model and for definitions of various terms, such as ballistic line, component velocity variance (CVV), etc.

Each error analysis model has been programmed in the ASCII FORTRAN language. Each separate program is named for its corresponding model. The implementation of these programs on the UNIVAC 1108 computer at White Sands Missile Range is described in this Users' Manual.

The utilization of the auxiliary program LRDC is described in Section 10.

2.0 PRELIMINARY CONSIDERATIONS

Each of the error analysis programs RAWIN, RADAR, and NAVAID, consists of a single main program unit. No subroutines are called. Each program may be executed in either batch or demand mode. The reader is referred to the accompanying listings for actual program source code.

Execution is similar for all three programs. One complete execution of any of the programs is referred to here as a complete run. A complete run consists of one or more separate problems. The general sequence of input and execution is described below.

STEP	EXPLANATION
1	Three card images are read on logical unit I05. These are used to document the complete run.
2	Each disk file described in Section 4 is read once on its appropriate logical unit. The program uses these inputs to perform preliminary computations required for the complete run.
3	Two card images are read on unit I05 in order to initiate the first problem. The first card image documents the problem, while the second contains data. Execution then procedes. Output is written to logical units I06 and I020.
4	Step 3 may be repeated for any number of problems. Program execution is terminated only by substituting an end-of-file image, i.e., @EOF, for any of the cards in Step 1 or 3.

None of the cards noted above may be omitted. In demand usage each of the input card images is solicited by the executing program.

None of the programs requires more than 6000 words of storage (IBANK plus DBANK) on the UNIVAC 1108. The demand time required for the execution of a complete run consisting of a single problem is on the order of ten seconds.

3.0 CARD INPUT

The card image inputs described below for each program are entered on logical unit IO5. Currently IO5 is taken to be unit 5, which on the UNIVAC 1108 corresponds to a card reader in batch usage or to terminal keyins in demand usage. Logical unit IO5 can be respecified to a different value by changing the appropriate data statement in each program.

3.1 RAWIN (Logical Unit IO5)

CARD	DATA	FORMAT
1	COMM	(20A4)
	COMM contains up to 80 characters which are used to document the complete run. A blank card may be used if no documentation is desired.	
2	COMM	(20A4)
	COMM contains up to 80 characters. It may contain a user supplied list of input files used for the complete run and/or it may contain further comment. This card may also be blank if desired.	
3	INTR	(A4)
	INTR may have the value YES or NO and must begin in column 1. If INTR is YES, results of preliminary and intermediate computations are outputted to unit IO20. If INTR is NO, only final results are outputted to unit IO20.	
4	COMM	(20A4)
	COMM contains up to 80 characters which are used to document the first problem. This card may be blank if desired.	
5	BEL, RE, BA, RA, RLED, RLEA, FE	Free Field
	This set of nonnegative real variables is input for the first problem.	

BEL	is the bias error (degrees) in elevation tracking of the apparent target.
RE	is the random error (degrees) in elevation tracking of the apparent target.
BA	is the bias error (degrees) in azimuth tracking of the apparent target.
RA	is the random error (degrees) in azimuth tracking of the apparent target.
RLED	is the random error (meters) associated with the measurement of the displacement of the launch site of the balloon-radiosonde combination from the receiving set.
RLEA	is the random error (degrees) associated with the launch azimuth.
FE	is the foreground elevation (degrees).

With changed information or values, cards 4 and 5 may be repeated in sequence any number of times in order to execute further problems. Values of all variables listed for card 5 must be entered for each problem, even if, for example, only one value is changed.

To terminate execution, enter a final input card containing the end-of-file image @EOF. If this is not done, the program will expect comment and data pertaining to further problems.

3.2 RADAR (Logical Unit I05)

CARD	DATA	FORMAT
1,2,3	Same description and formats as for RAWIN	
4	Initiates first problem. Same description and formats as for RAWIN.	
5	BEL, RE, BA, RA, BS, RS, RLED, RLEA, FE	Free Field
	This set of nonnegative real variables is input for the first problem.	

BEL, RE, BA, RA, RLED, RLEA, and FE are the same as described for RAWIN.

BS is the bias error (meters) in slant range.

RS is the random error (meters) in slant range.

Further problems are initiated in the same manner as described for RAWIN. Input of the card image @EOF is required to terminate execution.

3.3 NAVAID (Logical Unit 105)

CARD	DATA	FORMAT
1,2,3	Same description and formats as for RAWIN.	
4	Initiates first problem. Same description and - mats as for RAWIN.	
5	REX, REY, RLE	Free Field

This set of nonnegative real variables is input for the first problem.

REX is the random error (meters) associated with fixing the East coordinate of the ascending radiosonde.

REY is the random error (meters) associated with fixing the North coordinate of the ascending radiosonde.

RLE is the random error (meters) associated with the direct measurement of the launch position.

Further problems are initiated in the same manner as described for RAWIN. Input of the card image @EOF is required to terminate execution.

3.4 Example Card Input

RAWIN:

```
EXAMPLE RAWIN RUN USING 15 ZONES AND 3 ASCENT RATES
USE INPUT FILES AR, ZHHE, WF, UV, HRE, AD712
YES
EXAMPLE RAWIN PROBLEM
.03, .05, .03, .05, 5., 0., 5.
@EOF
```

RADAR:

```
EXAMPLE RADAR RUN USING 15 ZONES AND 3 ASCENT RATES
USE INPUT FILES AR, ZHHE, WF, UV, HRE, AD712
YES
EXAMPLE RADAR PROBLEM
.03, .05, .03, .05, 0., 16., 5., 0., 5.
@EOF
```

NAVAID:

```
EXAMPLE NAVAID RUN FOR 15 ZONES AND 3 ASCENT RATES
USE INPUT FILES AR, ZHHE, UV, WF
YES
EXAMPLE NAVAID PROBLEM
100., 100., 5.
@EOF
```

4.0 FILE INPUT

Each of the programs, RAWIN, RADAR, and NAVAID, requires data to be inputted from similar sets of disk files. For purposes of identification each required input file is given a name. Since the names are transparent to the programs, the user may rename the files to suit his own needs.

The input files are named, respectively, AR, ZHHE, UV, WF, HRE, and AD. RAWIN and RADAR each requires all of these files. NAVAID requires only AR, ZHHE, UV, and WF. In this section the files are described in the same order that they are read by the executing program.

The logical unit which each program uses to read a given file is designated by ION, where N is an appropriate integer. For example, file AR is read from unit IO2, where IO2 is currently assigned the value 2. If the user desires, any or all of the logical units may be reassigned to different values by changing the appropriate data statement in the program.

The following mnemonic labels are used here to describe the records in each file.

LABEL	EXPLANATION
IA	Balloon ascent rate index. IA = 1, NA
NA	Total number of balloon ascent rates. NA = 1, 2, 3, or 4
IZ	Ballistic zone index. IZ = 1, NZ
NZ	Total number of ballistic zones in the complete zone structure. For the NATO zone structure NZ = 15. However, the input files may be constructed for any value of NZ between 1 and 30.
IL	Ballistic line index. IL = 1, NL
NL	Total number of ballistic lines. NL = NZ

In each of the programs various arrays involving NZ and/or NL are currently dimensioned to allow for the NATO zone structure of 15 zones. These arrays must be redimensioned for larger zone structures.

4.1 File AR

File AR contains the balloon ascent rates.

Required by RAWIN, RADAR, and NAVAID

Logical unit IO2 (currently IO2 = 2)

Total number of records: NA

Number of data items per record: 1

RECORD	DATA	FORMAT
IA	AR(IA)	Free Field

AR(IA) is the ascent rate (meters/minute) for balloon IA.

4.2 File ZHHE

File ZHHE contains zone top altitudes and the bias and random errors associated with the determination of these altitudes.

Required by RAWIN, RADAR, and NAVAID

Logical unit IO3 (currently IO3 = 3)

Total number of records: NZ

Required number of data items per record: 3

RECORD	DATA	FORMAT
IZ	Z(IZ), BZ(IZ), RZ(IZ)	Free Field

Z(IZ) is the altitude (meters) at the top of zone IZ.

BZ(IZ) is the bias error (meters) in the determination of Z(IZ).

RZ(IZ) is the random error (meters) in the determination of Z(IZ).

4.3 File UV

File UV contains the zone wind profile
Required by RAWIN, RADAR, and NAVAID
Logical unit IO10 (currently IO10 = 10)
Total number of records: NZ
Required number of data items per record: 2

RECORD	DATA	FORMAT
IZ	U(IZ), V(IZ)	Free Field

U(IZ) is the East component (meters/second) of the average wind velocity in zone IZ.

V(IZ) is the North component (meters/second) of the average wind velocity in zone IZ.

4.4 File WF

File WF contains the zone wind weighting factors.
Required by RAWIN, RADAR, and NAVAID
Logical unit IO1 (currently IO1 = 1)
Total number of records: NL
Required number of data items per record: NZ

RECORD	DATA	FORMAT
IL	WF(1), WF(2),..., WF(IZ),..., WF(NZ)	Free Field

WF(IZ) is the wind weighting factor for zone IZ appropriate to ballistic line IL.

Each record must contain NZ values. This means that for IL less than NL, each record must be padded at the end with sufficient zero values to make the total number of data items in the record equal to NZ.

4.5 File HRE

For each ascent rate, file HRE contains values of positional variables relating to the launch site and to the radiosonde as it passes each zone top.

Required by RAWIN and RADAR
Logical unit I08 (currently I08 = 8)
Total number of records: NA * (NZ + 1)
Required number of data items per record: 2

For descriptive purposes we divide file HRE into NA successive groups, each group corresponding to a different value of ascent rate index IA and containing NZ + 1 records. The following is a description of records within any one group.

RECORD	DATA	FORMAT
1	DISPL(IA), AZL(IA)	(F10.0, 20X, F10.2)
	DISPL(IA) is the distance (meters) from the RAWIN or radar receiving set to the launch site for balloon ascent rate index IA.	
	AZL(IA) is the launch azimuth (degrees) for ascent rate index IA.	
1+IZ	E(IZ,IA), A(IZ,IA)	(20X, 2F10.2)
	E(IZ,IA) is the elevation (degrees) associated with radiosonde IA at the top of zone IZ.	
	A(IZ,IA) is the azimuth (degrees) associated with radiosonde IA at the top of zone IZ.	

For each ascent rate there is a group of records identical to the group listed above. The groups must be appended one after the other in file HRE in the same order that the ascent rates are entered in file AR. There are no blank records or other markers of any kind between the groups.

The X fields in this file can be used to store further data for informational purposes. For example, each record of the example HRE file in the accompanying listing contains information in the following order: horizontal distance, slant range, elevation, azimuth. This example file is constructed for 3 ascent rates and 15 zones; hence, each ascent rate group contains 16 records to yield a total of 48 records for the complete file.

4.6 File AD

File AD contains bias and random errors in elevation associated with ground reflection. These errors depend on a number of factors, including the antenna voltage pattern of the particular receiving set under consideration and the dielectric constant of the reflecting surface. The example AD file in the accompanying listing is mnemonically called AD712, corresponding to a seven foot diameter antenna and a surface dielectric constant of 12. Program LRDC may be used to generate file AD in the appropriate format.

Required by RAWIN and RADAR
Logical unit I09 (currently I09 = 9)
Total number of records: 279
Required number of data items per record for records 9 through 279: 2

In the following table the index J takes on the values J = 1, 271.

RECORD	DATA	FORMAT
1--8	Miscellaneous	(///////)
	Records 1-8 contain miscellaneous information describing the parameters which were used to create the AD file. (See example listing.) Program LRDC writes these records when it creates this file. Although the RAWIN and RADAR programs skip these records, they must be present. They may be blank if the user desires.	
8+J	BB(J), RR(J)	(8X, 2F15.8)

BB(J) is the bias error (degrees) in elevation due to ground reflection for a possible elevation angle of FLOAT(J-1)/3 degrees.

RR(J) is the random error (degree) in elevation due to ground reflection for a possible elevation angle of FLOAT(J-1)/3 degrees.

In other words, record 9 (J = 1) contains error data appropriate to 0.0 degrees elevation; record 10 (J = 2) contains error data for 0.33 degrees elevation; record 11 (J = 3) contains error data for 0.67 degrees elevation, and so on at 0.33 degree intervals. Finally record 279 (J = 271) contains error data for 90.0 degrees elevation.

If desired by the user, the X field in each record may contain a further datum for informational purposes. In the example file AD712 in the accompanying listing, each record 9 through 279 contains information in the following order: possible elevation angle, bias error due to reflection, random error due to reflection, the index J. (All this is generated by program LRDC.)

5.0 OUTPUT

A complete run of RAWIN, RADAR, or NAVAID produces two output print files. The program writes brief output to logical unit I06 (currently I06 = 6) and more extensive output to logical unit I020 (currently I020 = 20). If the user desires, the logical units may be redesignated to different values by changing the appropriate data statement in each program.

5.1 Output to Unit I06

In demand usage this output is directed to the demand terminal. The output is formatted for printing on a CRT screen which can display 80 characters per line. In batch mode the output to unit I06 is redundant; it will nevertheless be directed to a line printer unless the user takes steps to prevent this.

The first part of the output consists of solicitations for the card images described in Section 3 of this Users' Manual.

After the computations for any given problem are complete, the program writes brief results to unit I06. These results, which are entirely numerical, may be interpreted from the following table. (In this table the term 'record' is used rather loosely, since records '2' and '3' may each consist of several lines of output.)

RECORD	DATA	FORMAT
1	AR(1)	Free Field
	AR(1) is the ascent rate (meters/minute) for balloon 1.	
'2'	(CVV(IL,1), IL=1, NL)	(1X, 5F13.6)
	CVV(IL,1) is the component velocity variance (knots**2) in the ballistic wind computed for ballistic line IL and ascent rate index 1.	

'3'   (SIGMA(IL),1), IL=1, NL)   (1X, 5F13.6)

SIGMA(IL,1) is the standard deviation (knots) obtained from CVV(IL,1).

For a given problem the output described above is repeated for each balloon ascent rate specified in the run.

As an example, consider the case of 15 ballistic lines and one ascent rate. For this case record 1 consists of one printed line of data displaying the balloon ascent rate. Record '2' consists of three printed lines, five data items per line, containing the values of the CVV the values are printed from left to right in order of increasing ballistic line number IL. Record '3' also consists of three printed lines, five data items per line, and contains the values of SIGMA; the values are printed from left to right in order of increasing IL. Thus, for this example, the total number of printed lines of data is seven. For three ascent rates 21 lines are printed, and so on.

5.2 Output to Unit IO20

In either demand or batch mode, this output is meant to be directed to a line printer. In order for paging and line spacing commands to be honored, logical unit IO20 should represent an alternate print file.

If the user entered the value NO on input card 3, only a short, self-explanatory output listing is produced. It consists of the following:

Comments and user designated file names appropriate to the complete run;

Comments and input data for each individual problem;

For each problem, values of component velocity variance $(\text{knots})^2$ and standard deviation (knots) computed for each ballistic line for each ascent rate.

If the user entered YES on card 3, numerous preliminary and intermediate results are also outputted. The reader is referred the accompanying listings for examples of this output for each program.

6.0 JOB CONTROL

The job control run streams required by RAWIN, RADAR, and NAVAID are similar for all three programs. The main difference among them is due to the fact that NAVAID requires fewer input files than the other two.

Two example run streams for RAWIN are shown below for use on the UNIVAC 1108. Many variations on these are possible; see Reference 1. Individual variations for RADAR and NAVAID are noted at the end of each run stream.

6.1 Initial Batch Run

This run stream achieves the following:

Creates and lists individual temporary input data files from cards, where each file is designated by an appropriate logical unit number;

Creates a permanent program file called INPUTFILES and copies the individual temporary data files into separate elements in INPUTFILES;

Compiles program source language from cards and creates an absolute executable element;

Places symbolic, relocatable, and absolute elements into a newly created permanent program file called PROGRAM;

Executes the program for a complete run consisting of one problem;

Directs all output to a specific printed labelled PR3.

STEP	STATEMENT
1	@RUN with user supplied options and information
2	@PASSWD with valid user password
3	@SYM PRINT$,1,PR3
4	@ASG,CP INPUTFILES.
5	@USE I.,INPUTFILES.
6	@ASG,CP PROGRAM.
7	@USE P.,PROGRAM.
8	@ASG,CP 20.
9	@ASG,T 2.,///32
10	@ASG,T 3.,///32
11	@ASG,T 10.,///32
12	@ASG,T 1.,///32
13	@ASG,T 8.,///32
14	@ASG,T 9.,///32

```
15          @DATA,IL 2.
16          -- AR deck goes here --
17          @END
18          @DATA,IL 3.
19          -- ZHHE deck goes here --
20          @END
21          @DATA,IL 10.
22          -- UV deck goes here --
23          @END
24          @DATA,IL 1.
25          -- WF deck goes here --
26          @END
27          @DATA,IL 8.
28          -- HRE deck goes here --
29          @END
30          @DATA,IL 9.
31          -- AD deck goes here --
32          @END
33          @COPY,I 2.,I.AR
34          @COPY,I 3.,I.ZHHE
35          @COPY,I 10.,I.UV
36          @COPY,I 1.,I.WF
37          @COPY,I 8.,I.HRE
38          @COPY,I 9.,I.AD
39          @FREE I.
40          @FTN,IS P.RAWIN
41          -- RAWIN source deck goes here --
42          @MAP,I ,P.RAWIN
43           IN P.RAWIN
44           END
45          @XQT P.RAWIN
46          Card stating user comment for complete RAWIN run
47          Card designating files used and/or further comment
48          Card requesting or rejecting detailed output
49          Card stating user comment for first RAWIN problem
50          Card containing data for first RAWIN problem
51          @EOF
52          @FREE 20.
53          @SYM 20.,1,PR3
54          @FIN
```

Miscellaneous Variations

Steps 49 and 50 can be repeated for any number of problems. Insert additional pairs of cards after step 50.

The L option of each @DATA card causes a listing of the file data to be produced. If this listing is not desired, omit the L option.

If a permanent file containing data elements is not desired, omit Steps 4, 5, 33--39.

If a permanent file PROGRAM is not desired, omit Steps 6--7 and replace Steps 40--45 with the following sequence:

```
@FTN,IS
-- RAWIN source deck goes here --
@XQT
```

If only file creation without execution is desired, omit Steps 45--53.

Variations for RADAR

The job control sequence for RADAR is the same as for RAWIN. In the above run stream, simply replace the designation RAWIN, wherever it occurs, with RADAR.

Variations for NAVAID

The job control sequence for NAVAID is very similar to that for RAWIN. In the above run stream, simply replace the designation RAWIN, wherever it occurs, wih NAVAID. Since NAVAID does not require files HRE and AD, the following steps may be omitted: 13, 14, 27--32, 37, 38.

6.2 Typical Demand Run

It is assumed that all required input data exist in appropriately named elements in the permanent program file INPUTFILES. Also, it is assumed that an absolute element called RAWIN exists in file PROGRAM. Typically, the file PROGRAM will also contain symbolic and relocatable elements.

The creation of appropriately numbered temporary data files from elements in INPUTFILES can be a tedious task in demand mode. To facilitate the demand run, it is assumed that the user has previously created an element called, for example, RAWIN in a program file called ADDFILE. The contents of this element are shown below.

Contents of ADDFILE.RAWIN

RECORD	STATEMENT
1	@ASG,T 2.,///32
2	@ASG,T 3.,///32
3	@ASG,T 10.,///32
4	@ASG,T 1.,///32
5	@ASG,T 8.,///32
6	@ASG,T 9.,///32
7	@DATA,I 2.
8	@ADD,DP I.AR . UNIT 2
9	@END
10	@DATA,I 3.
11	@ADD,DP I.ZHHE . UNIT 3
12	@END
13	@DATA,I 10.
14	@ADD,DP I.UV . UNIT 10
15	@END
16	@DATA,I 1.
17	@ADD,DP I.WF . UNIT 1
18	@END
19	@DATA,I 8.
20	@ADD,DP I.HRE . UNIT 8
21	@END
22	@DATA,I 9.
23	@ADD,DP I.AD . UNIT 9
24	@END

An element ADDFILE.RADAR would be identical to the one listed above. In an element ADDFILE.NAVAID the following records could be omitted: 5, 6, 19--24.

Once the appropriate ADDFILE element has been created, it can be used with any number of future runs in demand mode. The actual demand run consists of the following steps (where it is assumed that the user is already properly signed on to the terminal).

STEP	STATEMENT
1	@ASG,AZ PROGRAM.
2	@ASG,AZ ADDFILE.
3	@ASG,AZ INPUTFILES.
4	@USE I.,INPUTFILES.
5	@ASG,CP 20.
6	@ADD ADDFILE.RAWIN
7	@XQT PROGRAM.RAWIN
8	Entry stating user comment for complete RAWIN run
9	Entry designating input files and/or further comment

10	Entry requesting or rejecting detailed output
11	Entry stating user comment for first RAWIN problem
12	Entry containing data for first RAWIN problem
13	@EOF
14	@FREE 20.
15	@SYM 20.,1,PR3
16	@FIN . IF DESIRED

Miscellaneous Variations

Steps 11 and 12 may be repeated in sequence for any number of problems.

If the user wants to test changes he may have made in the symbolic element PROGRAM.RAWIN, he can easily compile this element and execute it without retaining new relocatable and absolute elements. This is accomplished by replacing Step 7 with the following sequence:

```
@FTN,N PROGRAM.RAWIN,TPF$.RAWIN
@EOF
@XQT
```

The complete run stream listed above can also be used in batch mode if the following three cards are prefixed to it:

```
@RUN with user supplied options and information
@PASSWD with valid user password
@SYM PRINT$,1,PR3
```

The @SYM card listed here is necessary only if the user desires to direct the PRINT$ output (logical unit 6) to the specific printer PR3. The @FIN card of Step 16 is, of course, required in batch mode. In batch usage, the user may want to omit Step 2 and replace Step 6 with the 24 actual cards listed for the element ADDFILE.RAWIN; however, this is not necessary.

Variations for RADAR

The job control language for RADAR is the same as for RAWIN. In the above run stream, simply replace the designation RAWIN, wherever it exists, with RADAR. In Step 6, the element ADDFILE.RAWIN will also work

for RADAR, or the user may add the element ADDFILE.RADAR if it has been created.

Variations for NAVAID

In the above run stream, replace the designation RAWIN, wherever it exists, with NAVAID. It is assumed that an element ADDFILE.NAVAID exists for Step 6.

7.0 MODIFICATIONS

Certain easily implemented modifications to the error analysis programs are described below:

7.1 Logical Units

The logical units numbers used in input/output operations in RAWIN, RADAR, and NAVAID are assigned to integer variables (beginning with characters IO) in a DATA statement in each program. For example, in RAWIN we have

```
DATA IO1,IO2,IO3,IO5,IO6,IO8,IO9,IO10,IO20/1,2,3,5,6,8,9,10,20/
```

The user may change the assigned values in the DATA statement to suit his convenience and/or the requirements of the computer system. However, it is recommended that IO5 always correspond to a card reader or terminal keyin, IO6 to a line printer or terminal write, and IO20 to an alternate print file.

7.2 Redimensioning of Arrays

Pertinent arrays in RAWIN, RADAR, and NAVAID are currently dimensioned to accomodate 15 zones, 15 ballistic lines, and four balloon ascent rates. The DIMENSION statement in RAWIN, for example, is of the form:

```
DIMENSION  AR(4),BB(271),RR(271),U(15),DISPL(4),AZL(4),V(15),WO(15)
1          ,WF(15),Z(15),A(15,4),CVV(15,4),DXDA(15,4),DXDE(15,4),
2          DXDZ(15,4),DYDA(15,4),DYDE(15,4),DYDZ(15,4),E(15,4),
3          WV(15,15),SIGMA(15,4),VVX(15,4),VVY(15,4),W(15,15),
4          WU(15,15),BZ(15),RZ(15),COMM(20)
```

Structures of 15 zones or less do not require the redimensioning of arrays. Of course, care should be observed in preparing the various input data files, as described in Section 4. (For example, each of the programs determines the number of zones and ballistic lines from the number of records in file WF.)

Structures of up to 30 zones can be accommodated by the programs. For structures containing 16 to 30 zones, all of the array dimensions currently set at 15 must be changed to at least the maximum number of zones in the structure. For a structure of 26 zones, for example, U(15) becomes U(26), A(15,4) becomes A(26,4), W(15,15) becomes W(26,26), and so on. Array dimensions which are not currently set at 15 should not be changed.

7.3 Special Changes in NAVAID

If the user desires, any of the values assigned in the following DATA statement in NAVAID may be changed:

```
DATA TFIX, TLM, HINTL, HINTH, IZLO /1.,5.,200.,400.,5/
```

where the variables are defined below. Note the following restrictions: TFIX, TLM, HINTL, and HINTH must have real values greater than zero; IZLO may be zero or any positive integer.

VARIABLE	EXPLANATION
IZLO	Highest zone for which height interval HINTL is used. Currently IZLO = 5
HINTL HINTH	Height interval (meters) centered at zone tops and utilized in fixing the East and North coordinates of the ascending balloon. HINTL is used for IZ = 1, IZLO, and HINTH is used for IZ greater than IZLO. Currently HINTL = 200. meters and HINTH = 400 meters.
TFIX	Time interval (seconds) between successive hyperbolic fixes of balloon position. Currently TFIX = 1. second.
TLM	Amount of time (minutes) used in fixing the initial launch position. Currently TLM = 5. minutes.

8.0 PROGRAM SEQUENCE OF OPERATIONS

Each program performs computations and input/output operations in essentially the same sequence. The general program flow is given below:

STEP	EXPLANATION
1	Solicit and read on unit IO5 three card images containing general documentation and instructions for the complete run. Output the general documentation to unit IO20.
2	Read data from files AR, AHHE, and UV on appropriate logical units.
3	Read zone wind weighting factors, line by line, from file WF on unit IO1, and compute the weighting arrays W, WU, and WV.
4	Read files HRE and AD on the appropriate logical units. (Omit this step for NAVAID.)
5	Compute all required partial derivatives for each zone for each ascent rate.
6	Optionally output results of preliminary computations to unit IO20. These results include arrays W, WU, and WV, as well as arrays containing partial derivatives.
7	Solicit and read on unit IO5 the documentation card image and the data card image for specific problem, and output this information to unit IO20. If @EOF is read, skip to Step 18.
8	Do through Step 14 for ascent rate index IA = 1, NA.
9	Compute launch component errors appropriate to IA.
10	Do through Step 14 for ballistic line IL = 1, NL.
11	Compute all required individual error sums for IL, IA.
12	Optionally output individual error sums for IL, IA to unit IO20.
13	Compute East and North component variances in ballistic wind, VVX(IL, IA) and VVY(IL, IA), respectively.
14	Compute the component velocity variance CVV(IL, IA) in ballistic wind and its square root SIGMA(IL, IA).
15	Optionally output to unit IO20 the arrays VVX and VVY.
16	Output to units IO20 and IO6 the arrays CVV and SIGMA.

17 Return to Step 17 for next problem.

18 Terminate execution.

9.0 MNEMONICS

In all three error analysis programs the type of each variable is in general in accordance with the ASCII FORTRAN default rule. The only exceptions to the default rule involve certain explicitly defined character type variables containing page or column headings which are written to output. See program listings.

Numerous variables are defined elsewhere in this Users' Manual. These definitions are not repeated here. For convenience, however, reference is made below to the sections in which the definitions may be found. Also, the various error sums and required partial derivatives are discussed under separate headings. Finally, additional miscellaneous key variables are defined individually.

9.1 Variables Defined Elsewhere In This Users' Manual

It should be noted that the physical units of a variable may change during computation. For example, the program reads BA in degrees and later converts the units to radians.

Variables defined in Section 3:

BA, BEL, BS, COMM, FE, INTR, IO5, RA, RE, REX, REY, RLE, RLEA, RLED, RS.

Variables defined in Section 4:

A(IZ, IA), AR(IA), AZL(IA), BB(J), BZ(IZ), DISPL(IA), E(IZ,IA), IA, IL, IO1, IO2, IO3, IO8, IO9, IO10, IZ, NA, NL, NZ, RR(J), RZ(IZ), U(IZ), V(IZ), WF(IZ), Z(IZ).

Variables defined in Section 5.

AR(1), CVV(IL, 1), IO6, IO20, SIGMA(IL,1).

Variables defined in Section 7:

HINTH, HINTL, IZLO, TFIX, TLM.

9.2 Bias and Random Error Sums

Current values of the individual bias and random error sums are represented by nonsubscripted variable names which are comprised of four or five characters beginning with either BE or RE. See Volume I of this report of the definition of each of these sums.

9.3 Partial Derivatives (RAWIN and RADAR)

The mnemonic DpDq represents the partial derivative of p with respect to q. (However, see last paragraph under the current subheading.) In the Fortran code p and q are written as characters selected from the following list, where all distances are in meters and all angles are in radians.

p OR q	CHARACTER EXPLANATION
A	Azimuth of the balloon-borne radiosonde
D	Distance along the surface of the earth from the RAWIN or RADAR set to a point directly below the ascending radiosonde
E	Elevation of the radiosonde
S	Slant range (RADAR only)
X	East coordinate of radiosonde position
Y	North coordinate of radiosonde position
Z	Altitude of the radiosonde

For the most part, values of the partial derivative are contained in arrays indexed by IZ and IA. For example, DXDA(IZ,IA) represents the partial derivative (meters/radian) of the East coordinate of radiosonde position with respect to azimuth, appropriate to zone IZ and ascent rate index IA. Nonsubscripted partials represent current computational values only. A complete listing of partial derivatives utilized in RAWIN and/or RADAR follows, where IA = 1, NA, and IZ = 1, NZ; partials used only in RADAR are marked with an asterisk*:

DDDE, DDDZ, DXDA(IZ,IA), DXDE(IZ,IA), DXDZ(IZ,IA), DYDA(IZ,IA), DYDE(IZ,IA), DYDZ(IZ,IA), DZDE(IZ,IA)*, DXDS(IZ,IA)*.

In DO loops indexed by IA and IZ, a nonsubscripted variable of the form DpDqI is used as a convenience to hold temporarily the array value DpDq(IZ,IA). For example, DXDAI = DXDA(IZ,IA).

The variables DXDL, DXDLA, DYDL, and DYDLA are not strictly partial derivatives. They are defined below.

9.4 Miscellaneous Key Variables

Definitions of many of the variables used in RAWIN, RADAR, and NAVAID are given elsewhere in this Users' Manual, and the meanings of many others can be readily determined from an examination of the FORTRAN code itself. Only certain key remaining variables are defined in the following list. Indication is made of the program(s) in which each variable is used.

VARIABLE	EXPLANATION
BER	Current value of the bias error (degrees, radians) in elevation due to ground reflection. (RAWIN, RADAR)
CVV(IL,IA)	Component velocity variance $(\text{knots})^2$ in ballistic wind associated with ballistic line IL and ascent rate IA. (RAWIN, RADAR, NAVAID)
DXDL	Current value of the product (meters) of the random error in launch displacement times the partial derivative of the East launch coordinate with respect to launch displacement. (RAWIN, RADAR)
DXDLA	Current value of the product (meters) of the random error in launch azimuth times the partial derivative of the East launch coordinate with respect to launch azimuth. (RAWIN, RADAR)
DYDL	Similar to DXDL except that the partial derivative of the North launch coordinate is used. (RAWIN, RADAR)
DYDLA	Similar to DXDLA except that the partial derivative of the North launch coordinate is used. (RAWIN, RADAR)
D2R	Conversion factor, degrees to radians. (RAWIN, RADAR)
FNFL	Real variable representing the number of hyperbolic fixes of balloon launch position. (NAVAID)

FNFZ	Real variable representing the number of hyperbolic fixes of balloon position in the neighborhood of any zone top. (NAVAID)
G	Current value of the angle (radians) subtended at the center of the earth by the measuring set and the ascending balloon. (RAWIN, RADAR)
NFIXL	Number of hyperbolic fixes of balloon launch position. (NAVAID)
NFIXZH	Number of hyperbolic fixes of balloon position in the neighborhood of zone tops greater than IZLO. (NAVAID)
NFIXZL	Number of hyperbolic fixes of balloon position in the neighborhood of zone tops for zones IZ = 1, IZLO. (NAVAID)
Q	Current value of the ratio of the radius of the earth to the sum of the radius of the earth and the altitude of the ascending balloon. (RAWIN, RADAR)
R	Mean radius (meters) of the earth. (RAWIN, RADAR)
RER	Current value of the random error (degrees, radians) in elevation due to ground reflection. (RAWIN, RADAR)
SIGMA(IL,IA)	Standard deviation (knots) obtained from the component velocity variance in ballistic wind appropriate ballistic line IL and ascent rate IA. (RAWIN, RADAR, NAVAID)
TOKNOT	Conversion factor by division, meters/second to knots. (RAWIN, RADAR, NAVAID)
TOKN2	Conversion factor by division, $(\text{meters/second})^2$ to $(\text{knots})^2$. (RAWIN, RADAR, NAVAID)
VV	Current value of the component velocity variance $(\text{meters/second})^2$ in ballistic wind. (RAWIN, RADAR, NAVAID)
VVX(IL,IA)	Variance $(\text{meters/second})^2$ in the East component of ballistic wind for ballistic line IL, ascent rate IA. (RAWIN, RADAR, NAVAID)
VVY(IL,IA)	Variance $(\text{meters/second})^2$ in the North component of ballistic wind for ballistic line IL, ascent rate IA. (RAWIN, RADAR, NAVAID)
VV1	Current value of the variance $(\text{meters/second})^2$ in the East component of ballistic wind. (RAWIN, RADAR).
VV2	Current value of the variance $(\text{meter/second})^2$ in the North component of ballistic wind.(RAWIN, RADAR)

W(IZ,IL)	A defined weighting factor (1/meter) appropriate to ballistic line IL and equal to the wind weighting factor per unit zone width for zone IZ minus the wind weighting factor per unit zone width for zone IZ + 1 . (RAWIN, RADAR, NAVAID)
WU(IZ,IL)	A defined weighting factor (1/second) appropriate to ballistic line IL and equal to the product of the East component of zone wind times the wind weighting factor per unit zone width (all for zone IZ + 1) minus the product of the East component of zone wind times the wind weighting factor per unit zone width (all for zone IZ). (RAWIN, RADAR, NAVAID)
WV(IZ,IL)	A defined weighting factor (1/second) similar to WU(IZ, IL) except that the North component of zone wind is used. (RAWIN, RADAR, NAVAID)
WO(IL)	A defined weighting factor (1/meter) appropriate to ballistic line IL and equal to the negative of the wind weighting factor per unit zone width for zone 1. (RAWIN, RADAR, NAVAID)

10.0 PROGRAM LRDC

10.1 Introduction

The RAWIN and RADAR models require as input an estimate of the error in elevation angle of a radiosonde's position due to the fact that a portion of the signal reaching the RAWIN or RADAR set is reflected form the surface of the earth. The LRDC model provides such an estimate.

The reader is referred to Reference 2, for example, for a general discussion of tracking by the sequential lobing (or lobe switching) and conical scan techniques. In its current form LRDC is a simplified modelling of the sequential lobing technique. Reference 3 contains a useful discussion on tracking errors due to ground reflections.

The intent here is not to give a complete description of LRDC, which is still under development, but rather to point out some of the restrictions associated with its use:

> The antenna patterns for the upper beam and lower beam switched positions must have the same shape. Further development will be required to remove this restriction.
>
> In order to find the attenuation in amplitude of a reflected (vertically polarized) beam, the model currently assumes that the reflectivity is characterized completely by the angle of incidence of the beam at the surface of the reflecting medium and be the real dielectric constant of the medium. This restriction may be removed in further development to include the effect of signal frequency and the conductivity of the reflecting medium.

For each of the possible elevation angles 0., 0.33, 0.67, 1.00, 1.33, ..., 90.0 degrees, LRDC computes a bias error in elevation and a random error in elevation due to reflection. The computed bias error associated with a given elevation is typically much smaller than the random error and may be of either sign.

Program LRDC is written in the ASCII FORTRAN language. It may be executed in either demand or batch mode.

10.2 Card Input

In either demand or batch usage, each execution of program LRDC requires one input card image from logical unit I05 (currently I05 = 5).

CARD	DATA	FORMAT
1	AS, DC, SQA, B	Free Field

AS is the antenna size (dish diameter) in any convenient units. This parameter is used solely for documentation.

DC is the dielectric constant of the reflecting medium.

SQA is the squint angle (degrees) appropriate to the antenna pattern of the tracking device. Typically the upper beam antenna voltage pattern entered from file AV on logical unit I02 will already have the squint angle built into it; if this is the case, enter 0. for SQA.

B is the lower beam reduction factor. Enter 1. if the lower beam voltage pattern is not reduced in magnitude from the upper beam pattern.

10.3 File Input

Data describing the upper beam antenna voltage pattern are inputted from file AV.

Logical unit I02 (currently I02 = 2).

Total number of records: 1080.

Required number of data items per record: 4.

In the following table I takes on the values I = 1, 1080.

RECORD	DATA	FORMAT
I	T1(I), AV(I), DAV(I), DAV0(I)	Free Field

T1(I) is the angle (degrees) of the antenna beam pattern measured from the forward antenna axis. It must have the value

given by T1(I) = FLOAT(I-1)/3. -180. In other words, T1(1) = -180., T1(2) = -179.67, T1(3) = -179.33, ..., T1(541) = 0.00, ..., T1(1080) = 179.67, all in degrees.

AV(I) is the absolute value of the upper beam voltage corresponding to T1(I). Note that the values of the AV(I) are normalized such that the maximum value of the set of all the AV is equal to 1. (This maximum value will typically be located near, but not necessarily precisely at, index I = 541.)

DAV(I) is an antenna voltage difference given by DAV(I) = AV(I+1) -AV(I).

DAV0(I) is an antenna voltage difference given by DAV0(I) = (AV(I+1) -AV(I-1))/2.

The variables AV(I), DAV(I), and DAV0(I) should be entered to as many significant figures as is feasible.

10.4 Output

Program LRDC writes output to logical units 103 and 106. Currently 103 = 3, and 106 = 6. These units can be redesignated to different values by changing the appropriate data statement in LRDC.

10.4.1 Output to Unit I03

The output to unit I03 can be used to create an AD file suitable for use by programs RAWIN and RADAR.

Total number of records: 279.
Number of data items per record for records 9 through 279: 5.
In the following table J assumes the values J = 1, 271.

RECORD	DATA	FORMAT
1--8	Miscellaneous	Various
	These records repeat the card input data, display the computed elevation offset (degrees), and write column headings. (See AD712 listing.)	

8+J T1(J), ELAV(J), SIGMA(J), RMS(J), J (1X,F7.2,3F15.8,I5)

T1(J) is the possible target elevation angle (degrees) given by T1(J) = FLOAT(J-1)/3. (The program redefines the array T1 from its input values given in section 10.3 to the values noted here for output.)

ELAV(J) Is the computed mean elevation error (degrees) due to reflection for angle T1(J).

SIGMA(J) is the computed standard deviation (degrees) of elevation errors due to reflection for angle T1(J).

RMS(J) Is the computed root mean square error (degrees) in elevation due to reflection for angle T1(J).

J Is the counting index J = 1,271.

The values ELAV(J) and SIGMA(J) are taken, respectively, to be the bias and random error due to reflection for elevation angle T1(J). The quantities RMS(J) and J are outputted for informational purposes only.

The output to unit I03 is in the correct from of an AD file for input to programs RAWIN and RADAR. See the example file AD712 in the accompanying listing.

10.4.2 Output to Unit I06

In batch usage the output to unit I06 will result in a printed listing. In demand mode this output is directed to the demand terminal.

Output to unit I06 is similar to the ouput to unit I03. However, the following differences should be noted: The first eight records in the above table are omitted; the counting index J is replaced by an iteration index appropriate to each elevation angle.

10.5 Job Control

Shown below are two example LRDC run streams for use on the UNIVAC 1108. Numerous variations on these are possible. See Reference 1.

10.5.1 Initial Batch Run

This run stream achieves the following:

Creates from cards a data element AV7 in a previously catalogued file called INPUTFILES;

Compiles LRDC source language form cards and creates an absolute executable element;

Places symbolic, relocatable, and absolute elements into a previously catalogued file called PROGRAM;

Executes LRDC for the case of dielectric constant of 10.;

Places the resulting output to unit 3 into the element INPUTFILES.AD710.

STEP	STATEMENT
1	@RUN with user supplied options and information
2	@PASSWD with valid user password
3	@SYM PRINT$,1,PR3
4	@ASG.A INPUTFILES.
5	@USE I., INPUTFILES.
6	@ASG, A PROGRAM.
7	@USE P.,PROGRAM.
8	@ASG, T 2.
9	@ASG, T 3.
10	@DATA,I 2.
11	-- AV 7 deck goes here --
12	@END
13	@COPY, I 2., I.AV7
14	@FTN,IS P.LRDC
15	-- LRDC deck goes here --
16	@MAP,I ,P.LRDC
17	IN P.LRDC
18	END
19	@XQT P.LRDC
20	7., 10., 0., 1.
21	@ELT,ID I.AD710
22	@ADD,D 3.
23	@END
24	@FIN

10.5.2 Typical Demand Run

It is assumed that the input data from file AV7 exists in an element called INPUTFILES.AV7. It is also assumed that an absolute executable element called PROGRAM.LRDC exists.

The program is executed for an input dielectric constant of 12. the resulting ouput to logical unit 3 is catalogued in a data file called AD712 and is also placed in an element INPUTFILES.AD712.

After the user is properly signed on to the terminal, one possible sequence of commands is as follows:

STEP	STATEMENT
1	@ASG,AZ INPUTFILES.
2	@USE I.,INPUTFILES.
3	@ASG,AZ PROGRAM.
4	@USE P., PROGRAM.
5	@ASG,CP AD712.
6	@USE 3.,AD712.
7	@ASG,T 2.
8	@DATA,I 2.
9	@ADD,D I.AV7
10	@END
11	@XQT P.LRDC
12	7., 12., 0., 1.
13	@ELT,ID I.AD712
14	@ADD,D 3.
15	@END
16	@FIN. IF DESIRED

REFERENCES

1. Computer Branch, NROD, WSMR UNIVAC 1108 User Guide, Technical Report No. 69.

2. Skolnik, Merrill I., 1962, Introduction To Radar Systems, McGraw-Hill, NY.

3. Barr, William C., and Peterson, Arnold C., 1977, "Wind Measuring Accuracy Test of Meteorological Systems", ECOM-5831, Atmospheric Sciences Laboratory, US Army Electronics Command, White Sands Missile Range, NM.

COMPUTER LISTINGS

The following pages contain computer listings of programs RAWIN, RADAR, NAVAID, and LRDC. Example input tiles are also listed as well as output from sample runs. (Due to its length an example File AV is not listed.)

```
      PROGRAM RAWIN                                                     RW001
C                                                                       RW002
C     PROGRAM RAWIN MODELS INSTRUMENTAL (MEASUREMENT) ERROR IN BALLISTIC RW003
C     WIND VELOCITY FOR RAWIN SOUNDING SYSTEMS.  ITS INTENDED USE IS IN  RW004
C     THE TRASANA COEA FOR 'FAMAS' AND OTHER SYSTEMS.  THE PROGRAM       RW005
C     COMPUTES THE COMPONENT VELOCITY VARIANCE (CVV) AND ASSOCIATED      RW006
C     STANDARD DEVIATION IN BALLISTIC WIND FOR ALL BALLISTIC LINES       RW007
C     APPROPRIATE TO A GIVEN ZONE STRUCTURE.                             RW008
C                                                                       RW009
C     THE PROGRAM REQUIRES INPUT FROM FILES NOTED BELOW.  (FOR EXAMPLE,  RW010
C     FILE AD CONTAINS ELEVATION TRACKING ERRORS DUE TO GROUND REFLEC-   RW011
C     TION.  PROGRAM LRDC CAN BE USED TO COMPUTE THIS FILE.)             RW012
C                                                                       RW013
C     FOR INFORMATION ON THE USE OF PROGRAM RAWIN, SEE PSL PUBLICATION   RW014
C     'BALLISTIC WIND MEASUREMENT ERROR ANALYSIS'                        RW015
C     VOL. 1, MODEL FORMULATION                                          RW016
C     VOL. 2, USERS MANUAL                                               RW017
C                                                                       RW018
C     UNIT 101 = FILE WF INPUT                                           RW019
C     UNIT 102 = FILE AR INPUT                                           RW020
C     UNIT 103 = FILE ZHHE INPUT                                         RW021
C     UNIT 105 = REMOTE TERMINAL INPUT OR CARD READER                    RW022
C     UNIT 106 = REMOTE TERMINAL OUTPUT OR LINE PRINTER                  RW023
C     UNIT 108 = FILE HRE INPUT                                          RW024
C     UNIT 109 = FILE AD INPUT                                           RW025
C     UNIT 1010 = FILE UV INPUT                                          RW026
C     UNIT 1020 = ALTERNATE PRINT FILE TO BE DIRECTED TO LINE PRINTER    RW027
C                                                                       RW028
      DIMENSION AR(4),BB(271),RK(271),U(15),DISPL(4),AZL(4),V(15),WO(15) RW029
     1          ,WF(15),Z(15),A(15,4),CVV(15,4),DXDA(15,4),DXDE(15,4),    RW030
     2          DXDZ(15,4),DYDA(15,4),DYDE(15,4),DYDZ(15,4),E(15,4),      RW031
     3          WV(15,15),SIGMA(15,4),VVX(15,4),VVY(15,4),W(15,15),       RW032
     4          WU(15,15),BZ(15),RZ(15),COMM(20)                          RW033
      CHARACTER*6KNT,XCOMP,YCOMP                                         RW034
      CHARACTER*8STAN,VAR                                                RW035
      CHARACTER*9DEV,KNT2                                                RW036
      CHARACTER*10MS2                                                    RW037
      DATA R,TOKNOT/6371227.,0.514789/                                   RW038
      DATA NO/4HNO  /                                                    RW039
      DATA XCOMP,YCOMP,MS2/6H EAST ,6HNORTH ,10H(M/SEC)**2/              RW040
      DATA STAN,DEV,VAR/8HSTANDARD,9HDEVIATION,8HVARIANCE/               RW041
      DATA KNT,KNT2/6H(KNOT),9H(KNOT**2)/                                RW042
      DATA 101,102,103,105,106,108,109,1010,1020/1,2,3,5,6,8,9,10,20/    RW043
      D2R=1./57.29578                                                    RW044
      TOKN2=TOKNOT*TOKNOT                                                RW045
      IPROB=0                                                            RW046
C                                                                       RW047
C********************** GENERAL OUTPUT DOCUMENTATION ******************* RW048
C                                                                       RW049
C     INPUTS ARE REQUESTED TO BE USED FOR DOCUMENTING GENERAL OUTPUT     RW050
```

```
C     TO ALTERNATE PRINT UNIT 20.                                      RW051
C                                                                      RW052
      WRITE (1020,1010)                                                RW053
      WRITE (106,1020)                                                 RW054
      READ (105,1030,END=260) COMM                                     RW055
      WRITE (1020,1040) COMM                                           RW056
      WRITE (106,1050)                                                 RW057
      READ (105,1030,END=260) COMM                                     RW058
      WRITE (1020,1040) COMM                                           RW059
      WRITE (106,1060)                                                 RW060
      READ (105,1070,END=260) INTR                                     RW061
      WRITE (106,1080)                                                 RW062
C                                                                      RW063
C***** ENTER DATA FROM FILES AND PERFORM PRELIMINARY COMPUTATIONS ***** RW064
C                                                                      RW065
C     READ TABLE OF ASCENT RATES.                                      RW066
C                                                                      RW067
      IOERR=102                                                        RW068
      DO 10 IA=1,4                                                     RW069
      READ (102,1110,ERR=250,END=20) AR(IA)                            RW070
      NA=IA                                                            RW071
   10 CONTINUE                                                         RW072
C                                                                      RW073
C     READ TABLE OF ALTITUDES, BIAS AND                                RW074
C     RANDOM ERRORS ASSOCIATED WITH ZONE TOPS.                         RW075
C                                                                      RW076
   20 IOERR=103                                                        RW077
      DO 30 IZ=1,30                                                    RW078
      READ (103,1110,ERR=250,END=40) Z(IZ),BZ(IZ),RZ(IZ)               RW079
      NZ=IZ                                                            RW080
   30 CONTINUE                                                         RW081
   40 NL=NZ                                                            RW082
C                                                                      RW083
C     READ WIND PROFILE                                                RW084
C                                                                      RW085
      IOERR=1010                                                       RW086
      READ (1010,1110,ERR=250,END=250)(U(IZ),V(IZ),IZ=1,NZ)            RW087
C                                                                      RW088
C     READ TABLE OF WIND WEIGHTING FACTORS WF, LINE BY LINE.           RW089
C     FOR EACH ZONE FOR EACH LINE COMPUTE WEIGHTING                    RW090
C     ARRAY W  AND COMPONENT VELOCITY WEIGHTING ARRAYS WU AND WV.      RW091
C                                                                      RW092
      IOERR=101                                                        RW093
      DO 70 IL=1,NL                                                    RW094
      READ (101,1110,ERR=250,END=250)(WF(IZ),IZ=1,NZ)                  RW095
      B=WF(1)/Z(1)                                                     RW096
      WU(IL)=-B                                                        RW097
      IF (IL.EQ.1) GO TO 60                                            RW098
        DO 50 IZ=2,IL                                                  RW099
        IZM=IZ-1                                                       RW100
```

```
      BNEXT=WF(IZ)/(Z(IZ)-Z(IZM))
      W(IZM,IL)=B-BNEXT
      WU(IZM,IL)=BNEXT*U(IZ)-B*U(IZM)
      WV(IZM,IL)=BNEXT*V(IZ)-B*V(IZM)
      B=BNEXT
   50 CONTINUE
   60 W(IL,IL)=B
      WU(IL,IL)=-B*U(IL)
      WV(IL,IL)=-B*V(IL)
   70 CONTINUE
      DO 80 IA=1,NA
C
C     READ LAUNCH DISPLACEMENT AND LAUNCH AZIMUTH
C      FOR EACH BALLOON ASCENT RATE.
C
      IOERR=108
      READ (108,1120,ERR=250,END=250) DISPL(IA),AZL(IA)
C
C     READ TABLES OF ELEVATION AND AZIMUTH ANGLES AT ZONE TOPS FOR
C     EACH BALLOON ASCENT RATE.
C
      READ (108,1130,ERR=250,END=250)(E(IZ,IA),A(IZ,IA),IZ=1,NZ)
   80 CONTINUE
C
C     READ BIAS AND RANDOM ELEVATION ERRORS DUE TO GROUND REFLECTION.
C
      IOERR=109
      READ (109,1220,ERR=250,END=250)
      READ (109,1230,ERR=250,END=250)(BB(J),RR(J),J=1,271)
C
C     COMPUTE PARTIAL DERIVATIVES FOR EACH ZONE FOR EACH ASCENT RATE.
C
      DO 90 IA=1,NA
       DO 90 IZ=1,NZ
        AZ=D2R*A(IZ,IA)
        CA=COS(AZ)
        SA=SIN(AZ)
        EL=D2R*E(IZ,IA)
        SE=SIN(EL)
        CE=SQRT(1.-SE**2)
        Q=R/(R+Z(IZ))
        SR=SQRT(1.-(Q*CE)**2)
        DDDZ=Q*Q*CE/SR
        DDDE=-(1.-Q*SE/SR)*R
        G=(ARCOS(CE*Q)-EL)
        DXDZ(IZ,IA)=DDDZ*SA
        DYDZ(IZ,IA)=DDDZ*CA
        DXDE(IZ,IA)=DDDE*SA
        DYDE(IZ,IA)=DDDE*CA
        DXDA(IZ,IA)=R*G*CA
```

```
       DYDA(IZ,IA)=-R*G*SA                                              RW151
   90  CONTINUE                                                         RW152
C                                                                       RW153
C************* OPTIONAL OUTPUT OF PRELIMINARY COMPUTATIONS ************* RW154
C                                                                       RW155
      IF (INTR.EQ.NO) GO TO 140                                         RW156
      WRITE (1020,1160)(IZ,IZ=1,NZ)                                     RW157
      WRITE (1020,1340)                                                 RW158
      DO 100 IL=1,NL                                                    RW159
      WRITE (1020,1170) IL,WO(IL),(W(IZ,IL),IZ=1,NZ)                    RW160
      WRITE (1020,1110)                                                 RW161
  100 CONTINUE                                                          RW162
      WRITE (1020,1180)                                                 RW163
      WRITE (1020,1200)(IZ,IZ=1,NZ)                                     RW164
      WRITE (1020,1340)                                                 RW165
      DO 110 IL=1,NL                                                    RW166
      WRITE (1020,1210) IL,(WU(IZ,IL),IZ=1,NZ)                          RW167
      WRITE (1020,1110)                                                 RW168
  110 CONTINUE                                                          RW169
      WRITE (1020,1190)                                                 RW170
      WRITE (1020,1200)(IZ,IZ=1,NZ)                                     RW171
      WRITE (1020,1340)                                                 RW172
      DO 120 IL=1,NL                                                    RW173
      WRITE (1020,1210) IL,(WV(IZ,IL),IZ=1,NZ)                          RW174
      WRITE (1020,1110)                                                 RW175
  120 CONTINUE                                                          RW176
      DO 130 IA=1,NA                                                    RW177
      WRITE (1020,1240) AR(IA)                                          RW178
        DO 130 IZ=1,NZ                                                  RW179
        WRITE (1020,1250) IZ,DXDZ(IZ,IA),DYDZ(IZ,IA),DXDE(IZ,IA),       RW180
     1         DYDE(IZ,IA),DXDA(IZ,IA),DYDA(IZ,IA)                      RW181
  130   CONTINUE                                                        RW182
C                                                                       RW183
C*********** ENTER USER COMMENT AND DATA FOR SPECIFIC PROBLEM ********** RW184
C                                                                       RW185
  140 IPROB=IPROB+1                                                     RW186
      WRITE (106,1090) IPROB                                            RW187
      READ (105,1030,END=260) COMM                                      RW188
      WRITE (106,1100)                                                  RW189
      READ (105,1110,END=260) BEL,RE,BA,RA,RLED,RLEA,FE                 RW190
      WRITE (1020,1140) IPROB                                           RW191
      WRITE (1020,1040) COMM                                            RW192
      WRITE (1020,1150) BEL,RE,BA,RA,RLED,RLEA,FE                       RW193
C                                                                       RW194
C*********************** DO ERROR COMPUTATIONS ************************ RW195
C                                                                       RW196
      BEL=BEL*D2R                                                       RW197
      RE=RE*D2R                                                         RW198
      BA=BA*D2R                                                         RW199
      RA=RA*D2R                                                         RW200
```

```
      RLEA=RLEA*D2R                                                   RA201
      DO 180 IA=1,NA                                                  RW202
      IF (INTR.NE.NO) WRITE (1020,1260) IPROB,AR(IA)                  RW203
      ARI=AR(IA)/60.                                                  RW204
C                                                                     RW205
C     LAUNCH POINT ERROR.                                             RA206
C                                                                     RW207
      AZU=D2R*AZL(IA)                                                 RW208
      DXDL=RLED*SIN(AZU)                                              RW209
      DYDL=RLED*COS(AZU)                                              RA210
      DXDLA=RLEA*DISPL(IA)*COS(AZU)                                   RA211
      DYDLA=-RLEA*DISPL(IA)*SIN(AZU)                                  RW212
        DO 170 IL=1,NL                                                RW213
C                                                                     RW214
C     COMPUTE RANDOM ERROR IN LAUNCH COMPONENTS.                      RA215
C                                                                     RW216
        REXL=(DXDL*WU(IL)*ARI)**2+(DXDLA*WD(IL)*ARI)**2               RW217
        REYL=(DYDL*WU(IL)*ARI)**2+(DYDLA*WD(IL)*ARI)**2               RW218
C                                                                     RW219
C     INITIALIZE BIAS AND RANDOM ERROR SUMS FOR CURRENT               RW220
C      BALLISTIC LINE.                                                RW221
C                                                                     RW222
        BERXE=0.                                                      RW223
        BERYE=0.                                                      RW224
        BEXA=0.                                                       RW225
        BEYA=0.                                                       RW226
        REXA=0.                                                       RW227
        REYA=0.                                                       RW228
        BEXZ=0.                                                       RW229
        BEYZ=0.                                                       RW230
        REXZ=0.                                                       RW231
        REYZ=0.                                                       RW232
        BELXE=0.                                                      RW233
        BELYE=0.                                                      RW234
        RELXE=0.                                                      RW235
        RELYE=0.                                                      RW236
        RERXE=0.                                                      RW237
        RERYE=0.                                                      RW238
          DO 150 IZ=1,IL                                              RW239
C                                                                     RW240
C      ASSIGN CURRENT VALUES TO USEFUL COMBINATIONS OF VARIABLES.     RW241
C                                                                     RW242
          WAR=ARI*W(IZ,IL)                                            RW243
          BZI=BZ(IZ)                                                  RW244
          RZI=RZ(IZ)                                                  RW245
          BZIW=BZI*WAR                                                RW246
          RZIW=RZI*WAR                                                RW247
          DXDZI=DXDZ(IZ,IA)                                           RW248
          DYDZI=DYDZ(IZ,IA)                                           RW249
          DXDAI=DXDA(IZ,IA)                                           RW250
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```
            DYDAI=DYDA(IZ,IA)                                           RW251
            DXDEI=DXDE(IZ,IA)                                           RW252
            DYDEI=DYDE(IZ,IA)                                           RW253
C                                                                       RW254
C     INCREMENT ALTITUDE ERROR SUMS                                     RW255
C                                                                       RW256
            BEXZ=BEXZ+BZIW*DXDZI*WU(IZ,IL)*BZI                          RW257
            BEYZ=BEYZ+BZIW*DYDZI*WV(IZ,IL)*BZI                          RW258
            REXZ=REXZ+(RZIW*DXDZI*WU(IZ,IL)*RZI)**2                     RW259
            REYZ=REYZ+(RZIW*DYDZI*WV(IZ,IL)*RZI)**2                     RW260
C                                                                       RW261
C     FIND ERRORS IN ELEVATION DUE TO GROUND REFLECTION.                RW262
C                                                                       RW263
            EL3=3.*(E(IZ,IA)-FE)+1.                                     RW264
            IEL=EL3                                                     RW265
            IP=IEL+1                                                    RW266
            BER=BB(IEL)+(EL3-IEL)*(BB(IP)-BB(IEL))                      RW267
            RER=RR(IEL)+(EL3-IEL)*(RR(IP)-RR(IEL))                      RW268
            BER=BER*D2R                                                 RW269
            RER=RER*D2R                                                 RW270
C                                                                       RW271
C     INCREMENT ELEVATION ERROR SUMS                                    RW272
C                                                                       RW273
            BELXE=BELXE+BEL*DXDEI*WAR                                   RW274
            BERXE=BERXE+BER*DXDEI*WAR                                   RW275
            BELYE=BELYE+BEL*DYDEI*WAR                                   RW276
            BERYE=BERYE+BER*DYDEI*WAR                                   RW277
            RELXE=RELXE+(RE*DXDEI*WAR)**2                               RW278
            RERXE=RERXE+(RER*DXDEI*WAR)**2                              RW279
            RELYE=RELYE+(RE*DYDEI*WAR)**2                               RW280
            RERYE=RERYE+(RER*DYDEI*WAR)**2                              RW281
C                                                                       RW282
C     INCREMENT AZIMUTH ERROR SUMS.                                     RW283
C                                                                       RW284
            BEXA=BEXA+BA*DXDAI*WAR                                      RW285
            BEYA=BEYA+BA*DYDAI*WAR                                      RW286
            REXA=REXA+(RA*DXDAI*WAR)**2                                 RW287
            REYA=REYA+(RA*DYDAI*WAR)**2                                 RW288
  150       CONTINUE                                                    RW289
C                                                                       RW290
C     OPTIONAL OUTPUT OF THE INDIVIDUAL ERROR SUMS FOR BALLISTIC LINE IL RW291
C                                                                       RW292
          IF (INTR.EQ.NO) GO TO 160                                     RW293
          WRITE (1020,1270) IL,BEXZ**2,BELXE**2,BERXE**2,BEXA**2,BEYZ** RW294
     1          2,BELYE**2,BERYE**2,BEYA**2                             RW295
          WRITE (1020,1280) REXZ,REYZ,REXZ,RELXE,RERXE,REXA,REYZ,RELYE, RW296
     1          RERYE,REYA                                              RW297
C                                                                       RW298
C     COMBINE ERROR SUMS FOR EACH WIND COMPONENT, COMPUTE CVV,          RW299
C     AND CONVERT UNITS TO KNOTS**2.                                    RW300
```

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C                                                                        RW301
  160   VV1=BELXE**2+BERXE**2+BEXA**2+BEXZ**2+RELXE*RERXE+REXA+REXL+     RW302
     1          REXZ                                                     RW303
        VV2=BELYE**2+BERYE**2+BEYA**2+BEYZ**2+RELYE*RERYE+REYA+REYL+     RW304
     1          REYZ                                                     RW305
        VVX(IL,IA)=VV1                                                   RW306
        VVY(IL,IA)=VV2                                                   RW307
        VV=(VV1+VV2)/2                                                   RW308
        CVV(IL,IA)=VV/TOKN2                                              RW309
        SIGMA(IL,IA)=SQRT(CVV(IL,IA))                                    RW310
  170   CONTINUE                                                         RW311
  180 CONTINUE                                                           RW312
C                                                                        RW313
C     OPTIONAL OUTPUT OF VARIANCE IN COMPONENTS                          RW314
C                                                                        RW315
      IF (INTR.EQ.NO) GO TO 200                                          RW316
      WRITE (1020,1370) IPROB                                            RW317
      WRITE (1020,1360)(AR(IA),IA=1,NA)                                  RW318
      WRITE (1020,1380)(XCOMP,YCOMP,IA=1,NA)                             RW319
      WRITE (1020,1390)(VAR,VAR,IA=1,NA)                                 RW320
      WRITE (1020,1400)(MS2,MS2,IA=1,NA)                                 RW321
      WRITE (1020,1340)                                                  RW322
      DO 190 IL=1,NL                                                     RW323
      WRITE (1020,1350) IL,(VVX(IL,IA),VVY(IL,IA),IA=1,NA)               RW324
      WRITE (1020,1110)                                                  RW325
  190 CONTINUE                                                           RW326
C                                                                        RW327
C****** OUTPUT COMPONENT VELOCITY VARIANCE AND STANDARD DEVIATION ****** RW328
C                                                                        RW329
C     OUTPUT TO ALTERNATE PRINT FILE.                                    RW330
C                                                                        RW331
  200 NA0=1                                                              RW332
      NA1=NA                                                             RW333
      NA2=0                                                              RW334
      IF (NA.LE.4) GO TO 210                                             RW335
      NA2=NA-4                                                           RW336
      NA1=4                                                              RW337
  210 WRITE (1020,1290) IPROB                                            RW338
      WRITE (1020,1300)(AR(IA),IA=NA0,NA1)                               RW339
      WRITE (1020,1310)(VAR,STAN,IA=NA0,NA1)                             RW340
      WRITE (1020,1320)((DEV),IA=NA0,NA1)                                RW341
      WRITE (1020,1330)(KNT2,KNT,IA=NA0,NA1)                             RW342
      WRITE (1020,1340)                                                  RW343
      DO 220 IL=1,NL                                                     RW344
      WRITE (1020,1350) IL,(CVV(IL,IA),SIGMA(IL,IA),IA=NA0,NA1)          RW345
      WRITE (1020,1110)                                                  RW346
  220 CONTINUE                                                           RW347
      IF (NA2.EQ.0) GO TO 230                                            RW348
      NA0=NA1+1                                                          RW349
      NA1=NA                                                             RW350
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      NA2=0                                                             RW351
      GO TO 210                                                         RW352
C                                                                       RW353
C     OUTPUT TO TERMINAL FOR IMMEDIATE USE.                             RW354
C                                                                       RW355
  230 DO 240 IA=1,NA                                                    RW356
      WRITE (106,1110) AR(IA)                                           RW357
      WRITE (106,1360)(CVV(IL,IA),IL=1,NL)                              RW358
      WRITE (106,1360)(SIGMA(IL,IA),IL=1,NL)                            RW359
  240 CONTINUE                                                          RW360
C                                                                       RW361
C     LOOP BACK TO DO FURTHER PROBLEMS RELATED TO THE SAME INPUT FILES. RW362
C                                                                       RW363
      GO TO 140                                                         RW364
C                                                                       RW365
C***************************** PROGRAM END *************************** RW366
C                                                                       RW367
  250 WRITE (106,1410) IOERR                                            RW368
  260 WRITE (106,1420)                                                  RW369
      STOP                                                              RW370
C                                                                       RW371
C******************************* FORMATS ***************************** RW372
C                                                                       RW373
C                                                                       RW374
 1010 FORMAT (1H1,T52,26H ***** PROGRAM RAWIN *****///)                 RW375
 1020 FORMAT (1X,39HGENERAL DOCUMENTATION FOR PROGRAM RAWIN/1X,6HENTER  RW376
     1       19HONE LINE OF COMMENT)                                    RW377
 1030 FORMAT (20A4)                                                     RW378
 1040 FORMAT (1H0,20A4)                                                 RW379
 1050 FORMAT (1X,41HON ONE LINE ENTER FILE NAMES USED AND/OR /1X,       RW380
     1       15HFURTHER COMMENT)                                        RW381
 1060 FORMAT (1X,38HDO YOU WANT OUTPUT OF PRELIMINARY AND /1X,          RW382
     1       37HINTERMEDIATE COMPUTATIONS?  YES OR NO)                  RW383
 1070 FORMAT (A4)                                                       RW384
 1080 FORMAT (1X,48HGENERAL DOCUMETATION IS COMPLETE.  PROGRAM WILL /   RW385
     1       1X,51HNOW READ FILES AND PERFORM PRELIMINARY COMPUTATIONS) RW386
 1090 FORMAT (1X,37HENTER ONE LINE OF COMMENT FOR PROBLEM,I4/1X,        RW387
     1       47H(TO STOP EXECUTION ENTER AN END-OF-FILE MARKER))        RW388
 1100 FORMAT (1X,48HON ONE FREE FIELD LINE, ENTER NON-NEG. VALUES OF//  RW389
     1       1X,37H BEL,  RE,  BA,  RA, RLED, RLEA,  FE /1X,6H(DEG,     RW390
     2       31HDEG, DEG, DEG,   M ,  DEG, DEG))                        RW391
 1110 FORMAT ()                                                         RW392
 1120 FORMAT (F10.0,20X,F10.2)                                          RW393
 1130 FORMAT (20X,2F10.2)                                               RW394
 1140 FORMAT (1H1,7HPROBLEM,I4,47X,17HWIND ERROR INPUT /55X,8HASSUMED   RW395
     1       16HONE SIGMA ERRORS/)                                      RW396
 1150 FORMAT (/25X,10HELEVATION ,22HBIAS ERROR (DEGREES) =,F6.2,10X,    RW397
     1       10HELEVATION ,22HRANDOM ERR (DEGREES) =,F6.2//25X,         RW398
     2       8HAZIMUTH ,24HBIAS ERROR   (DEGREES) =,F6.2,10X,8HAZIMUTH  RW399
     3       ,24HRANDOM ERROR (DEGREES) =,F6.2//25X,7HDISPL. ,7HLAUNCH  RW400
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     4        18HERROR  (METERS)  =,F6.2,10X,14HAZIMUTH LAUNCH,7H ERROR   RW401
     5        11H(METERS)  =,F6.2//25X,11HFOREGROUND ,11HELEVATION (      RW402
     6        10HDEGREES) =,F6.2)                                          RW403
 1160 FORMAT (1H1,62X,7HARRAY W,/,62X,9H(1/METER),//,64X,4HZONE,/,         RW404
     1        16H    LINE       W0,10(9X,I2),2(/,16X,10(9X,I2)))           RW405
 1170 FORMAT (1H ,3X,I3,3X,11(E11.3),2(/21X,10E11.3))                      RW406
 1180 FORMAT (1H1,62X,8HARRAY W0)                                          RW407
 1190 FORMAT (1H1,62X,8HARRAY WV)                                          RW408
 1200 FORMAT (63X,7H(1/SEC),//64X,4HZONE,/,7H    LINE,10(9X,I3),2(/        RW409
     1        ,7X,10(9X,I3)))                                              RW410
 1210 FORMAT (3X,I3,6X,10(E12.3),2(/12X,10E12.3))                          RW411
 1220 FORMAT (////////)                                                    RW412
 1230 FORMAT (8X,2F15.8)                                                   RW413
 1240 FORMAT (1H1,52X,19HPARTIAL DERIVATIVES,/,50X,7HASCENT ,6HRATE =,     RW414
     1        F6.1,6H M/MIN,//,7H   ZONE,10X,4HDXDZ,16X,4HDYDZ,16X,        RW415
     2        4HDXDE,16X,4HDYDE,16X,4HDXDA,16X,4HDYDA,/43X,9(13X,          RW416
     3        7H(M/RAD)),/,130(1H,)/)                                      RW417
 1250 FORMAT (3X,I3,6(8X,E12.6)/)                                          RW418
 1260 FORMAT (1H1,8HPROBLEM ,I4,40X,15HINDIVIDUAL SUMS,/49X,7HASCENT ,     RW419
     1        6HRATE =,F6.1,6H M/MIN,//,1X,10HUNITS ARE 10H(M/SEC)**2,//   RW420
     2        /,8H    LINE,34X,7HBEXZ**2,4X,8HBELXE**2,3X,8HBERXE**2,3X,   RW421
     3        7HBEXA**2,4X,7HBEYZ**2,4X,8HBELYE**2,3X,8HBERYE**2,3X,       RW422
     4        7HBEYA**2,/,20X,4HREXL,7X,4HREYL,7X,4HREXZ,7X,5HRELXE,6X,    RW423
     5        5HRERXE,6X,4HREXA,7X,4HREYZ,7X,5HRELYE,6X,5HRERYE,6X,        RW424
     6        4HREYA,/,132(1H,)/)                                          RW425
 1270 FORMAT (4X,I3,9H   BIAS  ,22X,8(1X,F10.6))                           RW426
 1280 FORMAT (7X,9H   RANDOM,10(1X,F10.6)/)                                RW427
 1290 FORMAT (1H1,8HPROBLEM ,I4,36X,27HCOMPONENT VELOCITY VARIANCE//)      RW428
 1300 FORMAT (22H ASCENT RATE (M/MIN) =,8X,F6.1,22X,F6.1,22X,F6.1,22X,     RW429
     1        F6.1)                                                        RW430
 1310 FORMAT (7H0  LINE,6X,4(8X,A8,4X,A8))                                 RW431
 1320 FORMAT (13X,4(19X,A9))                                               RW432
 1330 FORMAT (13X,4(8X,A9,5X,A6))                                          RW433
 1340 FORMAT (130(1H-)/)                                                   RW434
 1350 FORMAT (3X,I3,10X,4(3X,F10.5,2X,F10.5,3X))                           RW435
 1360 FORMAT (1X,5F13.6)                                                   RW436
 1370 FORMAT (1H1,8HPROBLEM ,I4,40X,22HVARIANCE IN COMPONENTS,//)          RW437
 1380 FORMAT (7H0  LINE,5X,4(10X,A6,6X,A6))                                RW438
 1390 FORMAT (13X,4(8X,A8,4X,A8))                                          RW439
 1400 FORMAT (14X,4(6X,A10,2X,A10))                                        RW440
 1410 FORMAT (30H END-OF-FILE OR ERROR ON UNIT ,I2)                        RW441
 1420 FORMAT (44H EXECUTION OF THE PROGRAM IS NOW TERMINATED )             RW442
      END                                                                  RW443
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      PROGRAM RADAR                                                     RD001
C                                                                       RD002
C     PROGRAM RADAR MODELS INSTRUMENTAL (MEASUREMENT) ERROR IN BALLISTIC RD003
C     WIND VELOCITY FOR RADAR SYSTEMS.                                  RD004
C     IT COMPUTES THE COMPONENT VELOCITY VARIANCE (CVV) AND ASSOCIATED  RD005
C     STANDARD DEVIATION IN BALLISTIC WIND FOR ALL BALLISTIC LINES      RD006
C     APPROPRIATE TO A GIVEN ZONE STRUCTURE.                            RD007
C                                                                       RD008
C     THE PROGRAM REQUIRES INPUT FROM FILES NOTED BELOW.  (FOR EXAMPLE,  RD009
C     FILE AD CONTAINS ELEVATION TRACKING ERRORS DUE TO GROUND REFLEC-  RD010
C     TION.  PROGRAM LRDC CAN BE USED TO COMPUTE THIS FILE.)            RD011
C                                                                       RD012
C     FOR INFORMATION ON THE USE OF PROGRAM RADAR, SEE PSL PUBLICATION  RD013
C     'BALLISTIC WIND MEASUREMENT ERROR ANALYSIS'                       RD014
C     VOL. 1, MODEL FORMULATION                                         RD015
C     VOL. 2, USERS MANUAL                                              RD016
C                                                                       RD017
C     UNIT 101 = FILE WF INPUT                                          RD018
C     UNIT 102 = FILE AR INPUT                                          RD019
C     UNIT 103 = FILE ZHHE INPUT                                        RD020
C     UNIT 105 = REMOTE TERMINAL INPUT OR CARD READER                   RD021
C     UNIT 106 = REMOTE TERMINAL OUTPUT OR LINE PRINTER                 RD022
C     UNIT 108 = FILE HRE INPUT                                         RD023
C     UNIT 109 = FILE AD INPUT                                          RD024
C     UNIT 1010 = FILE UV INPUT                                         RD025
C     UNIT 1020 = ALTERNATE PRINT FILE TO BE DIRECTED TO LINE PRINTER   RD026
C                                                                       RD027
      DIMENSION AR(4),BB(271),RR(271),U(15),DISPL(4),AZL(4),V(15),WO(15) RD028
     1          ,WF(15),Z(15),A(15,4),CVV(15,4),DXDA(15,4),DXDE(15,4),  RD029
     2          DZDS(15,4),DZDE(15,4),DXDZ(15,4),DYDA(15,4),DYDE(15,4), RD030
     3          DYDZ(15,4),E(15,4),WV(15,15),SIGMA(15,4),VVX(15,4),     RD031
     4          VVY(15,4),W(15,15),WU(15,15),BZ(15),RZ(15),COMM(20)     RD032
      CHARACTER*6KNT,XCOMP,YCOMP                                        RD033
      CHARACTER*8STAN,VAR                                               RD034
      CHARACTER*9DEV,KNT2                                               RD035
      CHARACTER*10MS2                                                   RD036
      DATA R,TOKNOT/6371229.,0.514789/                                  RD037
      DATA NO/4HNO  /                                                   RD038
      DATA STAN,DEV,VAR/8HSTANDARD,9HDEVIATION,8HVARIANCE/              RD039
      DATA KNT,KNT2/6H(KNOT),9H(KNOT**2)/                               RD040
      DATA XCOMP,YCOMP,MS2/6H EAST ,6HNORTH ,10H(M/SEC)**2/             RD041
      DATA I01,I02,I03,I05,I06,I08,I09,I010,I020/1,2,3,5,6,8,9,10,20/   RD042
      D2R=1./57.29578                                                   RD043
      TOKN2=TOKNOT*TOKNOT                                               RD044
      IPROB=0                                                           RD045
C                                                                       RD046
C******************** GENERAL OUTPUT DOCUMENTATION ******************** RD047
C                                                                       RD048
C     INPUTS ARE REQUESTED TO BE USED FOR DOCUMENTING GENERAL OUTPUT    RD049
C     TO ALTERNATE PRINT UNIT 1020.                                     RD050
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C                                                                        RD051
      WRITE (1020,1010)                                                  RD052
      WRITE (106,1020)                                                   RD053
      READ (105,1030,END=240) COMM                                       RD054
      WRITE (1020,1040) COMM                                             RD055
      WRITE (106,1050)                                                   RD056
      READ (105,1030,END=240) COMM                                       RD057
      WRITE (1020,1040) COMM                                             RD058
      WRITE (106,1060)                                                   RD059
      READ (105,1070,END=240) INTR                                       RD060
      WRITE (106,1080)                                                   RD061
C                                                                        RD062
C***** ENTER DATA FROM FILES AND PERFORM PRELIMINARY COMPUTATIONS ****** RD063
C                                                                        RD064
C   READ TABLE OF ASCENT RATES.                                          RD065
C                                                                        RD066
      IOERR=102                                                          RD067
      DO 10 IA=1,4                                                       RD068
      READ (102,1130,ERR=230,END=20) AR(IA)                              RD069
      NA=IA                                                              RD070
   10 CONTINUE                                                           RD071
C                                                                        RD072
C     READ TABLE OF ALTITUDES, BIAS AND                                  RD073
C     RANDOM ERRORSASSOCIATED WITH ZONE TOPS.                            RD074
C                                                                        RD075
   20 IOERR=103                                                          RD076
      DO 30 IZ=1,30                                                      RD077
      READ (103,1130,ERR=230,END=40) Z(IZ),BZ(IZ),RZ(IZ)                 RD078
      NZ=IZ                                                              RD079
   30 CONTINUE                                                           RD080
   40 NL=NZ                                                              RD081
C                                                                        RD082
C     READ WIND PROFILE.                                                 RD083
C                                                                        RD084
      IOERR=1010                                                         RD085
      READ (1010,1130,ERR=230,END=230)(U(IZ),V(IZ),IZ=1,NZ)              RD086
C                                                                        RD087
C     READ TABLE OF WIND WEIGHTING FACTORS WF, LINE BY LINE.             RD088
C     FOR EACH ZONE FOR EACH LINE COMPUTE WEIGHTING                      RD089
C     ARRAY W  AND COMPONENT VELOCITY WEIGHTING ARRAYS WU AND WV.        RD090
C                                                                        RD091
      IOERR=101                                                          RD092
      DO 70 IL=1,NL                                                      RD093
      READ (101,1130,ERR=230,END=230)(WF(IZ),IZ=1,NZ)                    RD094
      B=WF(1)/Z(1)                                                       RD095
      WD(IL)=-B                                                          RD096
      IF (IL.EQ.1) GO TO 60                                              RD097
        DO 50 IZ=2,IL                                                    RD098
        IZM=IZ-1                                                         RD099
        BNEXT=WF(IZ)/(Z(IZ)-Z(IZM))                                      RD100
```

```
      W(IZM,IL)=B-BNEXT
      WU(IZM,IL)=BNEXT*U(IZ)-B*U(IZM)
      WV(IZM,IL)=BNEXT*V(IZ)-B*V(IZM)
      B=BNEXT
 50   CONTINUE
 60 W(IL,IL)=B
    WU(IL,IL)=-B*U(IL)
    WV(IL,IL)=-B*V(IL)
 70 CONTINUE
    DO 80 IA=1,NA
C
C     READ LAUNCH DISPLACEMENT AND LAUNCH AZIMUTH
C     FOR EACH BALLOON ASCENT RATE.
C
      IOERR=108
      READ (108,1110,ERR=230,END=230) DISPL(IA),AZL(IA)
C
C    READ TABLES OF ELEVATION AND AZIMUTH ANGLES AT ZONE TOPS FOR
C    EACH BALLOON ASCENT RATE.
C
      READ (108,1120,ERR=230,END=230)(E(IZ,IA),A(IZ,IA),IZ=1,NZ)
 80 CONTINUE
C
C   READ BIAS AND RANDOM ELEVATION ERRORS DUE TO GROUND REFLECTION.
C
      IOERR=109
      READ (109,1140,ERR=230,END=230)
      READ (109,1150,ERR=230,END=230)(BB(J),RR(J),J=1,271)
C
C     COMPUTE PARTIAL DERIVATIVES FOR EACH ZONE FOR EACH ASCENT RATE.
C
      DO 90 IA=1,NA
        DO 90 IZ=1,NZ
        AZ=D2R*A(IZ,IA)
        CA=COS(AZ)
        SA=SIN(AZ)
        EL=D2R*E(IZ,IA)
        SE=SIN(EL)
        CE=SQRT(1.-SE**2)
        Q=R/(R+Z(IZ))
        SR=SQRT(1.-(Q*CE)**2)
        DDDZ=G*Q*CE/SR
        DDDE=-(1-Q*SE/SR)*R
        G=ARCOS(CE*Q)-EL
        DXDZ(IZ,IA)=DDDZ*SA
        DYDZ(IZ,IA)=DDDZ*CA
        DXDE(IZ,IA)=DDDE*SA
        DYDE(IZ,IA)=DDDE*CA
        DYDE(IZ,IA)=DDDE*CA
        DXDA(IZ,IA)=R*G*CA
```

```
          DYDA(IZ,IA)=-R*G*SA                                             RD0151
          DZDS(IZ,IA)=SR                                                  RD0152
          DZDE(IZ,IA)=R*SIN(G)                                            RD0153
   90   CONTINUE                                                          RD0154
C                                                                         RD0155
C************ OPTIONAL OUTPUT OF PRELIMINARY COMPUTATIONS **************  RD0156
C                                                                         RD0157
      IF (INTR.EQ.NO) GO TO 140                                           RD0158
      WRITE (1020,1160)(IZ,IZ=1,NZ)                                       RD0159
      WRITE (1020,1340)                                                   RD0160
      DO 100 IL=1,NL                                                      RD0161
      WRITE (1020,1170) IL,WU(IL),(W(IZ,IL),IZ=1,NZ)                      RD0162
      WRITE (1020,1130)                                                   RD0163
  100 CONTINUE                                                            RD0164
      WRITE (1020,1180)                                                   RD0165
      WRITE (1020,1200)(IZ,IZ=1,NZ)                                       RD0166
      WRITE (1020,1340)                                                   RD0167
      DO 110 IL=1,NL                                                      RD0168
      WRITE (1020,1210) IL,(WU(IZ,IL),IZ=1,NZ)                            RD0169
      WRITE (1020,1130)                                                   RD0170
  110 CONTINUE                                                            RD0171
      WRITE (1020,1190)                                                   RD0172
      WRITE (1020,1200)(IZ,IZ=1,NZ)                                       RD0173
      WRITE (1020,1340)                                                   RD0174
      DO 120 IL=1,NL                                                      RD0175
      WRITE (1020,1210) IL,(WV(IZ,IL),IZ=1,NZ)                            RD0176
      WRITE (1020,1130)                                                   RD0177
  120 CONTINUE                                                            RD0178
      DO 130 IA=1,NA                                                      RD0179
      WRITE (1020,1240) AR(IA)                                            RD0180
        DO 130 IZ=1,NZ                                                    RD0181
        WRITE (1020,1250) IZ,DXDZ(IZ,IA),DYDZ(IZ,IA),DXDE(IZ,IA),         RD0182
     1          DYDE(IZ,IA),DXDA(IZ,IA),DYDA(IZ,IA),DZDS(IZ,IA),          RD0183
     2          DZDE(IZ,IA)                                               RD0184
  130   CONTINUE                                                          RD0185
C                                                                         RD0186
C********** ENTER USER COMMENT AND DATA FOR SPECIFIC PROBLEM ***********  RD0187
C                                                                         RD0188
  140 IPROB=IPROB+1                                                       RD0189
      WRITE (106,1090) IPROB                                              RD0190
      READ (105,1030,END=290) COMM                                        RD0191
      WRITE (106,1100)                                                    RD0192
      READ (105,1130,END=290) BEL,RE,BA,RA,BS,RS,RLED,RLEA,FE             RD0193
      WRITE (1020,1220) IPROB                                             RD0194
      WRITE (1020,1040) COMM                                              RD0195
      WRITE (1020,1230) BEL,RE,BA,RA,BS,RS,RLED,RLEA,FE                   RD0196
C                                                                         RD0197
C*********************** DO ERROR COMPUTATIONS ***********************   RD0198
C                                                                         RD0199
      BEL=BEL*D2R                                                         RD0200
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```
      RE=RE*D2R                                                         RD201
      BA=BA*D2R                                                         RD202
      RA=RA*D2R                                                         RD203
      RLEA=RLEA*D2R                                                     RD204
      DO 180 IA=1,NA                                                    RD205
      IF (INTR.NE.NO) WRITE (1020,1260) IPROB,AR(IA)                    RD206
      ARI=AR(IA)/60.                                                    RD207
C                                                                       RD208
C     LAUNCH POINT ERROR.                                               RD209
C                                                                       RD210
      AZO=D2R*AZL(IA)                                                   RD211
      DXDL=RLED*SIN(AZO)                                                RD212
      DYDL=RLED*COS(AZO)                                                RD213
      DXDLA=RLEA*DISPL(IA)*COS(AZO)                                     RD214
      DYDLA=-RLEA*DISPL(IA)*SIN(AZO)                                    RD215
        DO 170 IL=1,NL                                                  RD216
C                                                                       RD217
C     COMPUTE RANDOM ERROR IN LAUNCH COMPONENTS.                        RD218
C                                                                       RD219
        REXL=(DXDL*WO(IL)*ARI)**2+(DXDLA*WO(IL)*AF )**2                 RD220
        REYL=(DYDL*WO(IL)*ARI)**2+(DYDLA*WO(IL)*ARI)**2                 RD221
C                                                                       RD222
C     INITIALIZE BIAS AND RANDOM ERROR SUMS FOR CURRENT BALLISTIC LINE. RD223
C                                                                       RD224
        BERXE=0.                                                        RD225
        BERYE=0.                                                        RD226
        BEXA=0.                                                         RD227
        BEYA=0.                                                         RD228
        REXA=0.                                                         RD229
        REYA=0.                                                         RD230
        BEXS=0.                                                         RD231
        BEYS=0.                                                         RD232
        REXS=0.                                                         RD233
        REYS=0.                                                         RD234
        BELXE=0.                                                        RD235
        BELYE=0.                                                        RD236
        RELXE=0.                                                        RD237
        RELYE=0.                                                        RD238
        RERXE=0.                                                        RD239
        RERYE=0.                                                        RD240
          DO 150 IZ=1,IL                                                RD241
C                                                                       RD242
C     ASSIGN CURRENT VALUES TO USEFUL COMBINATIONS OF VARIABLES.        RD243
C                                                                       RD244
          WAR=ARI*W(IZ,IL)                                              RD245
          DXDZI=DXDZ(IZ,IA)                                             RD246
          DYDZI=DYDZ(IZ,IA)                                             RD247
          DXDAI=DXDA(IZ,IA)                                             RD248
          DYDAI=DYDA(IZ,IA)                                             RD249
          DXDEI=DXDE(IZ,IA)                                             RD250
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```
              DYDEI=DYDE(IZ,IA)                                              RD251
              DZDSI=DZDS(IZ,IA)                                              RD252
              DZDEI=DZDE(IZ,IA)                                              RD253
      C                                                                      RD254
      C     INCREMENT SLANT RANGE ERROR SUMS.                                RD255
      C                                                                      RD256
              BEXS=BEXS+BS*(DXDZI*WAR+DZDSI*WU(IZ,IL))                       RD257
              BEYS=BEYS+BS*(DYDZI*WAR+DZDSI*WV(IZ,IL))                       RD258
              REXS=REXS+(RS*(DXDZI*WAR+DZDSI*WU(IZ,IL)))**2                  RD259
              REYS=REYS+(RS*(DYDZI*WAR+DZDSI*WV(IZ,IL)))**2                  RD260
      C                                                                      RD261
      C     FIND ERRORS IN ELEVATION DUE TO GROUND REFLECTION.               RD262
      C                                                                      RD263
              EL3=3.*(E(IZ,IA)-FE)+1.                                        RD264
              IEL=EL3                                                        RD265
              IP=IEL+1                                                       RD266
              BER=BB(IEL)+(EL3-IEL)*(BB(IP)-BB(IEL))                         RD267
              RER=RR(IEL)+(EL3-IEL)*(RR(IP)-RR(IEL))                         RD268
              BER=BER*D2R                                                    RD269
              RER=RER*D2R                                                    RD270
      C                                                                      RD271
      C     INCREMENT ELEVATION ERROR SUMS.                                  RD272
      C                                                                      RD273
              BELXE=BELXE+BEL*(DXDEI*WAR+DZDEI*WU(IZ,IL))                    RD274
              BERXE=BERXE+BER*(DXDEI*WAR+DZDEI*WU(IZ,IL))                    RD275
              BELYE=BELYE+BEL*(DYDEI*WAR+DZDEI*WV(IZ,IL))                    RD276
              BERYE=BERYE+BER*(DYDEI*WAR+DZDEI*WV(IZ,IL))                    RD277
              RELXE=RELXE+(RE*(DXDEI*WAR+DZDEI*WU(IZ,IL)))**2                RD278
              RELYE=RELYE+(RE*(DYDEI*WAR+DZDEI*WV(IZ,IL)))**2                RD279
              RERXE=RERXE+(RER*(DXDEI*WAR+DZDEI*WU(IZ,IL)))**2               RD280
              RERYE=RERYE+(RER*(DYDEI*WAR+DZDEI*WV(IZ,IL)))**2               RD281
      C                                                                      RD282
      C    INCREMENT AZIMUTH ERROR SUMS.                                     RD283
      C                                                                      RD284
              BEXA=BEXA+BA*DXDAI*WAR                                         RD285
              BEYA=BEYA+BA*DYDAI*WAR                                         RD286
              REXA=REXA+(RA*DXDAI*WAR)**2                                    RD287
              REYA=REYA+(RA*DYDAI*WAR)**2                                    RD288
        150   CONTINUE                                                       RD289
      C                                                                      RD290
      C     OPTIONAL OUTPUT OF THE INDIVIDUAL ERROR SUMS FOR BALLISTIC LINE IL RD291
      C                                                                      RD292
            IF (INTR.EQ.NO) GO TO 160                                        RD293
            WRITE (1020,1270) IL,BEXS**2,BELXE**2,BERXE**2,BEXA**2,BEYS**    RD294
           1     2,BELYE**2,BERYE**2,BEYA**2                                 RD295
            WRITE (1020,1280) REXL,REYL,REXS,RELXE,RERXE,REXA,REYS,RELYE,    RD296
           1     RERYE,REYA                                                  RD297
      C                                                                      RD298
      C    COMBINE SUMS IN EACH WIND COMPONENT, COMPUTE CVV,                 RD299
      C    AND CONVERT UNITS TO KNOTS**2.                                    RD300
```

```
C
  160   VV1=BEXS**2+BELXE**2+BEMXE**2+BEXA**2+REXS+RELXE+REMXE+REXA+
     1        REXL
        VV2=BEYS**2+BELYE**2+BEMYE**2+BEYA**2+REYS+RELYE+REMYE+REYA+
     1        REYL
        VVX(IL,IA)=VV1
        VVY(IL,IA)=VV2
        VV=(VV1+VV2)/2
        CVV(IL,IA)=VV/TOKN2
        SIGMA(IL,IA)=SQRT(CVV(IL,IA))
  170   CONTINUE
  180 CONTINUE
C
C     OPTIONAL OUTPUT OF VARIANCE IN COMPONENTS
C
      IF (INTR.EQ.NO) GO TO 200
      WRITE (1020,1370) IPROB
      WRITE (1020,1300)(AR(IA),IA=1,NA)
      WRITE (1020,1380)(XCOMP,YCOMP,IA=1,NA)
      WRITE (1020,1390)(VAR,VAR,IA=1,NA)
      WRITE (1020,1400)(MS2,MS2,IA=1,NA)
      WRITE (1020,1340)
      DO 190 IL=1,NL
      WRITE (1020,1350) IL,(VVX(IL,IA),VVY(IL,IA),IA=1,NA)
      WRITE (1020,1130)
  190 CONTINUE
C
C****** OUTPUT COMPONENT VELOCITY VARIANCE AND STANDARD DEVIATION ******
C
C     OUTPUT TO ALTERNATE PRINT FILE.
C
  200 WRITE (1020,1290) IPROB
      WRITE (1020,1300)(AR(IA),IA=1,NA)
      WRITE (1020,1310)(VAR,STAN,IA=1,NA)
      WRITE (1020,1320)((DEV),IA=1,NA)
      WRITE (1020,1330)(KNT2,KNT,IA=1,NA)
      WRITE (1020,1340)
      DO 210 IL=1,NL
      WRITE (1020,1350) IL,(CVV(IL,IA),SIGMA(IL,IA),IA=1,NA)
      WRITE (1020,1130)
  210 CONTINUE
C
C     OUTPUT TO TERMINAL FOR IMMEDIATE USE.
C
      DO 220 IA=1,NA
      WRITE (106,1130) AR(IA)
      WRITE (106,1360)(CVV(IL,IA),IL=1,NL)
      WRITE (106,1360)(SIGMA(IL,IA),IL=1,NL)
  220 CONTINUE
C
```

```
C     LOOP BACK TO DO FURTHER PROBLEMS RELATED TO THE SAME INPUT FILES.    RD351
C                                                                          RD352
      GO TO 140                                                            RD353
C                                                                          RD354
C************************** PROGRAM END ****************************      RD355
C                                                                          RD356
  230 WRITE (106,1410) IOERR                                               RD357
  240 WRITE (106,1420)                                                     RD358
      STOP                                                                 RD359
C                                                                          RD360
C*************************** FORMATS *******************************      RD361
C                                                                          RD362
C                                                                          RD363
 1010 FORMAT (1H1,T52,26H ***** PROGRAM RADAR *****///)                    RD364
 1020 FORMAT (1X,39HGENERAL DOCUMENTATION FOR PROGRAM RADAR/1X,6HENTER     RD365
     1       19HONE LINE OF COMMENT)                                       RD366
 1030 FORMAT (20A4)                                                        RD367
 1040 FORMAT (1H0,20A4)                                                    RD368
 1050 FORMAT (1X,41HON ONE LINE ENTER FILE NAMES USED AND/OR /1X,          RD369
     1       15HFURTHER COMMENT)                                           RD370
 1060 FORMAT (1X,38HDO YOU WANT OUTPUT OF PRELIMINARY AND /1X,             RD371
     1       37HINTERMEDIATE COMPUTATIONS? YES OR NO)                      RD372
 1070 FORMAT (A4)                                                          RD373
 1080 FORMAT (1X,49HGENERAL DOCUMENTATION IS COMPLETE.  PROGRAM WILL /     RD374
     1       1X,51HNOW READ FILES AND PERFORM PRELIMINARY COMPUTATIONS)    RD375
 1090 FORMAT (1X,37HENTER ONE LINE OF COMMENT FOR PROBLEM,I4/1X,           RD376
     1       47H(TO STOP EXECUTION ENTER AN END-OF-FILE MARKER))           RD377
 1100 FORMAT (1X,48HON ONE FREE FIELD LINE, ENTER NON-NEG. VALUES OF//     RD378
     1       1X,49H BEL,  RE,  BA,  RA,   BS,   RS, RLED, RLEA,  FE /      RD379
     2       1X,49H(DEG, DEG, DEG, DEG,    M ,   M ,   M ,  DEG, DEG))     RD380
 1110 FORMAT (F10.0,20X,F10.2)                                             RD381
 1120 FORMAT (20X,2F10.2)                                                  RD382
 1130 FORMAT ()                                                            RD383
 1140 FORMAT (////////)                                                    RD384
 1150 FORMAT (8X,2F15.8)                                                   RD385
 1160 FORMAT (1H1,62X,7HARRAY W,/,62X,9H(1/METER),//,64X,4HZONE,/,         RD386
     1       16H    LINE       NU,10(9X,I2),2(/,16X,10(9X,I2)))            RD387
 1170 FORMAT (1H ,3X,I3,3X,11(E11.3),2(/21X,10E11.3))                      RD388
 1180 FORMAT (1H1,62X,8HARRAY WU)                                          RD389
 1190 FORMAT (1H1,62X,8HARRAY WV)                                          RD390
 1200 FORMAT (63X,7H(1/SEC),//64X,4HZONE,/,7H   LINE,10(9X,I3),2(/         RD391
     1       ,7X,10(9X,I3)))                                               RD392
 1210 FORMAT (3X,I3,6X,10(E12.3),2(/12X,10E12.3))                          RD393
 1220 FORMAT (1H1,7HPROBLEM,I4,47X,17HWIND ERROR INPUT /55X,8HASSUMED      RD394
     1       16HONE SIGMA ERRORS/)                                         RD395
 1230 FORMAT (/25X,10HELEVATION ,22HBIAS ERROR (DEGREES) =,F6.2,10X,       RD396
     1       10HELEVATION ,21HRANDOM ERR (DEGREES) 1H=,F6.2//25X,          RD397
     2       8HAZIMUTH ,14HBIAS ERROR    (10HDEGREES) =,F6.2,10X,          RD398
     3       8HAZIMUTH ,7HRANDOM 17HERROR (DEGREES) =,F6.2//25X,           RD399
     4       8HRANGE   ,25HBIAS   ERROR  (METERS)  =,F6.2,10X,7HRANGE      RD400
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      5        ,24HRANDOM ERROR (METERS)  =,F6.2//25X,7HDISPL. ,7HLAUNCH   RD0401
      6        18HERROR  (METERS)  =,F6.2,10X,19HAZIMUTH LAUNCH,7H ERROR   RD0402
      7        11H(METERS)  =,F6.2//25X,11HFOREGROUND ,11HELEVATION (      RD0403
      8        8HDEGREES)2H =,F6.2)                                        RD0404
 1240 FORMAT (1H1,52X,19HPARTIAL DERIVATIVES,/,50X,7HASCENT ,6HRATE =,     RD0405
      1        F6.1,6H M/MIN,//,7H   ZONE,5X,4HDXDZ,11X,4HDYDZ,11X,4HDXDE  RD0406
      2        ,11X,4HDYDE,11X,4HDXDA,11X,4HDYDA,11X,4HDZDS,11X,4HDZDE,/   RD0407
      3        ,130(1H.))                                                  RD0408
 1250 FORMAT (3X,I3,8(3X,E12.6)/)                                          RD0409
 1260 FORMAT (1H1,8HPROBLEM ,I4,40X,15HINDIVIDUAL SUMS,/,49X,7HASCENT      RD0410
      1        6HRATE =,F6.1,6H M/MIN,//,1X,10HUNITS ARE 10H(M/SEC)**2,//  RD0411
      2        /,8H    LINE,34X,7HBEXS**2,4X,8HBELXE**2,3X,8HBERXE**2,3X,  RD0412
      3        7HBEXA**2,4X,7HBEYS**2,4X,8HBELYE**2,3X,8HBERYE**2,3X,      RD0413
      4        7HBEYA**2,/,20X,4HREXL,7X,4HREYL,7X,4HREXS,7X,5HRELXE,6X,   RD0414
      5        5HRERXE,6X,4HREXA,7X,4HREYS,7X,5HRELYE,6X,5HRERYE,6X,       RD0415
      6        4HREYA,/,132(1H.)/)                                         RD0416
 1270 FORMAT (4X,I3,9H    BIAS  ,22X,8(1X,F10.6))                          RD0417
 1280 FORMAT (7X,9H   RANDOM,10(1X,F10.6)/)                                RD0418
 1290 FORMAT (1H1,8HPROBLEM ,I4,36X,27HCOMPONENT VELOCITY VARIANCE//)      RD0419
 1300 FORMAT (21H ASCENT RATE, M/MIN =,8X,F6.1,22X,F6.1,22X,F6.1,22X,      RD0420
      1        F6.1)                                                       RD0421
 1310 FORMAT (7H0  LINE,14X,4(A8,4X,A8,8X))                                RD0422
 1320 FORMAT (32X,4(A9,19X))                                               RD0423
 1330 FORMAT (13X,4(8X,A9,5X,A6))                                          RD0424
 1340 FORMAT (125(1H.))                                                    RD0425
 1350 FORMAT (3X,I3,10X,4(3X,F10.5,2X,F10.5,3X))                           RD0426
 1360 FORMAT (1X,5F13.6)                                                   RD0427
 1370 FORMAT (1H1,8HPROBLEM ,I4,40X,22HVARIANCE IN COMPONENTS,//)          RD0428
 1380 FORMAT (7H0  LINE,5X,4(10X,A6,6X,A6))                                RD0429
 1390 FORMAT (13X,4(8X,A8,4X,A8))                                          RD0430
 1400 FORMAT (14X,4(6X,A10,2X,A10))                                        RD0431
 1410 FORMAT (30H END-OF-FILE OR ERROR ON UNIT ,I2)                        RD0432
 1420 FORMAT (44H EXECUTION OF THE PROGRAM IS NOW TERMINATED )             RD0433
      END                                                                  RD0434
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      PROGRAM NAVAID                                                    NV001
C                                                                       NV002
C    PROGRAM NAVAID MODELS INSTRUMENTAL (MEASUREMENT) ERROR IN BALLISTIC NV003
C     WIND VELOCITY FOR NAVAID SYSTEMS.  ITS INTENDED USE IS IN         NV004
C     THE TRASANA COEA FOR *FAMAS*.  THE PROGRAM                        NV005
C     COMPUTES THE COMPONENT VELOCITY VARIANCE (CVV) AND ASSOCIATED     NV006
C     STANDARD DEVIATION IN BALLISTIC WIND FOR ALL BALLISTIC LINES      NV007
C     APPROPRIATE TO A GIVEN ZONE STRUCTURE.                            NV008
C                                                                       NV009
C     THE PROGRAM REQUIRES INPUT FROM FILES NOTED BELOW.                 NV010
C                                                                       NV011
C     FOR INFORMATION ON THE USE OF PROGRAM NAVAID, SEE PSL PUBLICATION NV012
C     'BALLISTIC WIND MEASUREMENT ERROR ANALYSIS'                       NV013
C     VOL. 1, MODEL FORMULATION                                         NV014
C     VOL. 2, USERS MANUAL                                              NV015
C                                                                       NV016
C     UNIT 101 = FILE WF INPUT                                          NV017
C     UNIT 102 = FILE AR INPUT                                          NV018
C     UNIT 103 = FILE ZHHE INPUT                                        NV019
C     UNIT 105 = REMOTE TERMINAL INPUT OR CARD READER                   NV020
C     UNIT 106 = REMOTE TERMINAL OUTPUT OR LINE PRINTER                 NV021
C     UNIT 1010 = FILE UV INPUT                                         NV022
C     UNIT 1020 = ALTERNATE PRINT FILE TO BE DIRECTED TO LINE PRINTER   NV023
C                                                                       NV024
      DIMENSION AR(4),WF(15),W(15,15),Z(15),U(15),V(15),CVV(15,4),      NV025
     1          SIGMA(15,4),VVX(15,4),VVY(15,4),WO(15),WU(15,15),       NV026
     2          WV(15,15),BZ(15),RZ(15),COMM(20)                        NV027
      CHARACTER*6KNT,XCOMP,YCOMP                                        NV028
      CHARACTER*8STAN,VAR                                               NV029
      CHARACTER*9DEV,KNT2                                               NV030
      CHARACTER*10MS2                                                   NV031
      DATA TFIX,TLM,MINTL,MINTH,IZLO/1.,5.,200.,400.,5/                 NV032
      DATA TOKNOT/0.514789/                                             NV033
      DATA NO/4HNO  /                                                   NV034
      DATA XCOMP,YCOMP,MS2/6H EAST ,6HNORTH ,10H(M/SEC)**2/             NV035
      DATA STAN,DEV,VAR/8HSTANDARD,9HDEVIATION,8HVARIANCE/              NV036
      DATA KNT,KNT2/6H(KNOT),9H(KNOT**2)/                               NV037
      DATA I01,I02,I03,I05,I06,I010,I020/1,2,3,5,6,10,20/               NV038
      NFIXL=INT(60.*TLM/TFIX)                                           NV039
      FNFL=FLOAT(NFIXL)                                                 NV040
      TOKN2=TOKNOT*TOKNOT                                               NV041
      IPROB=0                                                           NV042
C                                                                       NV043
C******************** GENERAL OUTPUT DOCUMENTATION ******************** NV044
C                                                                       NV045
C     INPUTS ARE REQUESTED TO BE USED FOR DOCUMENTING GENERAL OUTPUT    NV046
C     TO ALTERNATE PRINT UNIT 1020.                                     NV047
C                                                                       NV048
      WRITE (1020,1010)                                                 NV049
      WRITE (106,1020)                                                  NV050
```

```
      READ (105,1030,END=210) COMM                                      NV051
      WRITE (1020,1040) COMM                                            NV052
      WRITE (106,1050)                                                  NV053
      READ (105,1030,END=210) COMM                                      NV054
      WRITE (1020,1040) COMM                                            NV055
      WRITE (106,1060)                                                  NV056
      READ (105,1070,END=210) INTR                                      NV057
      WRITE (106,1090)                                                  NV058
C                                                                       NV059
C****** ENTER DATA FROM FILES AND PERFORM PRELIMINARY COMPUTATION ******NV060
C                                                                       NV061
C   READ TABLE OF ASCENT RATES.                                         NV062
C                                                                       NV063
      IOERR=102                                                         NV064
      DO 10 IA=1,4                                                      NV065
      READ (102,1080,ERR=200,END=20) AR(IA)                             NV066
      NA=IA                                                             NV067
   10 CONTINUE                                                          NV068
C                                                                       NV069
C     READ TABLE OF ALTITUDES, BIAS AND                                 NV070
C     RANDOM ERRORS ASSOCIATED WITH ZONE TOPS.                          NV071
C                                                                       NV072
   20 IOERR=103                                                         NV073
      DO 30 IZ=1,30                                                     NV074
      READ (103,1080,ERR=200,END=40) Z(IZ),BZ(IZ),RZ(IZ)                NV075
      NZ=IZ                                                             NV076
   30 CONTINUE                                                          NV077
   40 NL=NZ                                                             NV078
C                                                                       NV079
C   INPUT WIND PROFILE.                                                 NV080
C                                                                       NV081
      IOERR=1010                                                        NV082
      READ (1010,1080,ERR=200,END=200)(U(IZ),V(IZ),IZ=1,NZ)             NV083
C                                                                       NV084
C     READ TABLE OF WIND WEIGHTING FACTORS WF, LINE BY LINE.            NV085
C     FOR EACH ZONE FOR EACH LINE COMPUTE WEIGHTING                     NV086
C     ARRAY W  AND COMPONENT VELOCITY WEIGHTING ARRAYS WU AND WV.       NV087
C                                                                       NV088
      IOERR=101                                                         NV089
      DO 70 IL=1,NL                                                     NV090
      READ (101,1080,ERR=200,END=200)(WF(IZ),IZ=1,NZ)                   NV091
      B=WF(1)/Z(1)                                                      NV092
      W0(IL)=-B                                                         NV093
      IF (IL.EQ.1) GO TO 60                                             NV094
        DO 50 IZ=2,IL                                                   NV095
        IZM=IZ-1                                                        NV096
        BNEXT=WF(IZ)/(Z(IZ)-Z(IZM))                                     NV097
        W(IZM,IL)=B-BNEXT                                               NV098
        WU(IZM,IL)=BNEXT*U(IZ)-B*U(IZM)                                 NV099
        WV(IZM,IL)=BNEXT*V(IZ)-B*V(IZM)                                 NV100
```

```
            B=BNEXT
   50   CONTINUE
   60 W(IL,IL)=B
      WU(IL,IL)=-B*U(IL)
      WV(IL,IL)=-B*V(IL)
   70 CONTINUE
C
C************ OPTIONAL OUTPUT OF PRELIMINARY COMPUTATIONS *************
C
      IF (INTR.EQ.NO) GO TO 110
      WRITE (1020,1150)(IZ,IZ=1,NZ)
      WRITE (1020,1280)
      DO 80 IL=1,NL
      WRITE (1020,1160) IL,WU(IL),(W(IZ,IL),IZ=1,NZ)
      WRITE (1020,1080)
   80 CONTINUE
      WRITE (1020,1170)
      WRITE (1020,1190)(IZ,IZ=1,NZ)
      WRITE (1020,1280)
      DO 90 IL=1,NL
      WRITE (1020,1200) IL,(WU(IZ,IL),IZ=1,NZ)
      WRITE (1020,1080)
   90 CONTINUE
      WRITE (1020,1180)
      WRITE (1020,1190)(IZ,IZ=1,NZ)
      WRITE (1020,1280)
      DO 100 IL=1,NL
      WRITE (1020,1200) IL,(WV(IZ,IL),IZ=1,NZ)
      WRITE (1020,1080)
  100 CONTINUE
C
C************* ENTER USER COMMENT AND DATA FROM TERMINALS *************
C
  110 IPROB=IPROB+1
      WRITE (106,1100) IPROB
      READ (105,1030,END=210) COMM
      WRITE (106,1110)
      READ (105,1080) REX,REY,RLE
      WRITE (1020,1120) IPROB
      WRITE (1020,1040) COMM
      WRITE (1020,1130) REX,REY,RLE
C
C*********************** DO ERROR COMPUTATIONS ************************
C
C   BEGIN ERROR COMPUTATION.
C
      DO 150 IA=1,NA
      IF (INTR.NE.NO) WRITE (1020,1210) IPROB,AR(IA)
      ARI=AR(IA)/60.
      NFIXZL=INT(HINTL/(ARI*TFIX))
```

```
      NFIXZH=INT(HINTH/(ARI*TFIX))                                      NV151
        DO 140 IL=1,NL                                                  NV152
        WARU=ARI*WD(IL)                                                 NV153
C                                                                       NV154
C     COMPUTE RANDOM ERROR IN LAUNCH COMPONENTS                         NV155
C                                                                       NV156
        REXL=(WARD**2)*(REX**2/FNFL+RLE**2/2.)                          NV157
        REYL=(WARD**2)*(REY**2/FNFL+RLE**2/2.)                          NV158
C                                                                       NV159
C     INITIALIZE BIAS AND RANDOM ERROR SUMS FOR CURRENT BALLISTIC LINE. NV160
C                                                                       NV161
        BEXZ=0.                                                         NV162
        BEYZ=0.                                                         NV163
        REXZ=0.                                                         NV164
        REYZ=0.                                                         NV165
        REXX=0.                                                         NV166
        REYY=0.                                                         NV167
        FNFZ=FLOAT(NFIXZL)                                              NV168
          DO 120 IZ=1,IL                                                NV169
C                                                                       NV170
C     ASSIGN CURRENT VALUES TO USEFUL COMBINATIONS OF VARIABLES.        NV171
C                                                                       NV172
          IF (IZ.GT.IZLO) FNFZ=FLOAT(NFIXZH)                            NV173
          WAR=ARI*W(IZ,IL)                                              NV174
          BZI=BZ(IZ)                                                    NV175
          RZI=RZ(IZ)                                                    NV176
C                                                                       NV177
C     INCREMENT ALTITUDE SUMS.                                          NV178
C                                                                       NV179
          BEXZ=BEXZ+WU(IZ,IL)*BZI                                       NV180
          BEYZ=BEYZ+WV(IZ,IL)*BZI                                       NV181
          REXZ=REXZ+(WU(IZ,IL)*RZI)**2                                  NV182
          REYZ=REYZ+(WV(IZ,IL)*RZI)**2                                  NV183
          REXX=REXX+(REX*WAR)**2/FNFZ                                   NV184
          REYY=REYY+(REY*WAR)**2/FNFZ                                   NV185
  120     CONTINUE                                                      NV186
C                                                                       NV187
C     OPTIONAL OUTPUT OF THE INDIVIDUAL ERROR SUMS FOR BALLISTIC LINE IL NV188
C                                                                       NV189
        IF (INTR.EQ.NO) GO TO 130                                       NV190
        WRITE (1020,1220) IL,REXL,REYL,BEXZ**2,REXZ,REXX,BEYZ**         NV191
     1      2,REYZ,REYY                                                 NV192
C                                                                       NV193
C     COMBINE SUMS IN EACH WIND COMPONENT, COMPUTE COMPONENT VELOCITY VA NV194
C     AND CONVERT UNITS TO KNOTS**2.                                    NV195
C                                                                       NV196
  130   VVX(IL,IA)=REXL+REXX+REXZ+BEXZ**2                               NV197
        VVY(IL,IA)=REYL+REYY+REYZ+BEYZ**2                               NV198
        VV=(VVX(IL,IA)+VVY(IL,IA))/2                                    NV199
        CVV(IL,IA)=VV/TOKN2                                             NV200
```

```
      SIGMA(IL,IA)=SQRT(CVV(IL,IA))                                     NV201
  140   CONTINUE                                                        NV202
  150 CONTINUE                                                          NV203
C                                                                       NV204
C     OPTIONAL OUTPUT OF VARIANCE IN COMPONENTS                         NV205
C                                                                       NV206
      IF (INTR.EQ.NO) GO TO 170                                         NV207
      WRITE (1020,1300) IPROB                                           NV208
      WRITE (1020,1240)(AR(IA),IA=1,NA)                                 NV209
      WRITE (1020,1310)(XCOMP,YCOMP,IA=1,NA)                            NV210
      WRITE (1020,1320)(VAR,VAR,IA=1,NA)                                NV211
      WRITE (1020,1330)(MS2,MS2,IA=1,NA)                                NV212
      WRITE (1020,1280)                                                 NV213
      DO 160 IL=1,NL                                                    NV214
      WRITE (1020,1290) IL,(VVX(IL,IA),VVY(IL,IA),IA=1,NA)              NV215
      WRITE (1020,1080)                                                 NV216
  160 CONTINUE                                                          NV217
C                                                                       NV218
C****** OUTPUT COMPONENT VELOCITY VARIANCE AND STANDARD DEVIATION ******NV219
C                                                                       NV220
C    OUTPUT TO ALTERNATE PRINT FILE                                     NV221
C                                                                       NV222
  170 WRITE (1020,1230) IPROB                                           NV223
      WRITE (1020,1240)(AR(IA),IA=1,NA)                                 NV224
      WRITE (1020,1250)(VAR,STAN,IA=1,NA)                               NV225
      WRITE (1020,1260)((DEV),IA=1,NA)                                  NV226
      WRITE (1020,1270)(KNT2,KNT,IA=1,NA)                               NV227
      WRITE (1020,1280)                                                 NV228
      DO 180 IL=1,NL                                                    NV229
      WRITE (1020,1290) IL,(CVV(IL,IA),SIGMA(IL,IA),IA=1,NA)            NV230
      WRITE (1020,1080)                                                 NV231
  180 CONTINUE                                                          NV232
C                                                                       NV233
C    OUTPUT TO TERMINAL FOR IMMEDIATE USE.                              NV234
C                                                                       NV235
      DO 190 IA=1,NA                                                    NV236
      WRITE (106,1080) AR(IA)                                           NV237
      WRITE (106,1140)(CVV(IL,IA),IL=1,NL)                              NV238
      WRITE (106,1140)(SIGMA(IL,IA),IL=1,NL)                            NV239
  190 CONTINUE                                                          NV240
C                                                                       NV241
C     LOOP BACK TO DO FURTHER PROBLEMS RELATED TO THE SAME INPUT FILES. NV242
C                                                                       NV243
      GO TO 110                                                         NV244
C                                                                       NV245
C************************* PROGRAM END *********************************NV246
C                                                                       NV247
  200 WRITE (106,1340) IOERR                                            NV248
  210 WRITE (106,1350)                                                  NV249
      STOP                                                              NV250
```

```
C                                                                       NV251
C•••••••••••••••••••••••••••••• FORMATS •••••••••••••••••••••••••••••••• NV252
C                                                                       NV253
C                                                                       NV254
 1010 FORMAT (1H1,T52,27H ••••• PROGRAM NAVAID •••••///)                NV255
 1020 FORMAT (1X,40HGENERAL DOCUMENTATION FOR PROGRAM NAVAID/1X,6HENTER NV256
     1          19HONE LINE OF COMMENT)                                 NV257
 1030 FORMAT (20A4)                                                     NV258
 1040 FORMAT (1H0,20A4)                                                 NV259
 1050 FORMAT (1X,41HON ONE LINE ENTER FILE NAMES USED AND/OR /1X,       NV260
     1          15HFURTHER COMMENT)                                     NV261
 1060 FORMAT (1X,38HDO YOU WANT OUTPUT OF PRELIMINARY AND /1X,          NV262
     1          37HINTERMEDIATE COMPUTATIONS?  YES OR NO)               NV263
 1070 FORMAT (A4)                                                       NV264
 1080 FORMAT ()                                                         NV265
 1090 FORMAT (1X,49HGENERAL DOCUMENTATION IS COMPLETE.  PROGRAM WILL /  NV266
     1          1X,51HNOW READ FILES AND PERFORM PRELIMINARY COMPUTATIONS) NV267
 1100 FORMAT (1X,37HENTER ONE LINE OF COMMENT FOR PROBLEM,I4/1X,        NV268
     1          47H(TO STOP EXECUTION ENTER AN END-OF-FILE MARKER))     NV269
 1110 FORMAT (1X,48HON ONE FREE FIELD LINE, ENTER NON-NEG. VALUES OF//  NV270
     1          1X,17H REX,  REY,  RLE /1X,17H (M      M      M) )      NV271
 1120 FORMAT (1H1,7HPROBLEM,I4,47X,17HWIND ERROR INPUT /55X,8HASSUMED   NV272
     1          16HONE SIGMA ERRORS/)                                   NV273
 1130 FORMAT (/50X,31HEAST TRACKING ERROR  (METERS) =,F8.2,//50X,       NV274
     1          31HNORTH TRACKING ERROR (METERS) =,F8.2,//50X,7HRANDOM  NV275
     2          24HLAUNCH ERROR  (METERS) =,F8.2)                       NV276
 1140 FORMAT (1X,5F13.6)                                                NV277
 1150 FORMAT (1H1,62X,7HARRAY W,/,62X,9H(1/METER),//,64X,4HZONE,/,      NV278
     1          16H    LINE       WU,10(9X,I2),2(/,16X,10(9X,I2)))      NV279
 1160 FORMAT (1H ,3X,I3,3X,11(E11.3),2(/21X,10E11.3))                   NV280
 1170 FORMAT (1H1,62X,8HARRAY WU)                                       NV281
 1180 FORMAT (1H1,62X,8HARRAY WV)                                       NV282
 1190 FORMAT (63X,7H(1/SEC),//64X,4HZONE,/,7H   LINE,10(9X,I3),2(/      NV283
     1          ,7X,10(9X,I3)))                                         NV284
 1200 FORMAT (3X,I3,6X,10(E12.3),2(/12X,10E12.3))                       NV285
 1210 FORMAT (1H1,8HPROBLEM ,I4,41X,15HINDIVIDUAL SUMS,/,49X,7HASCENT,  NV286
     1          6HRATE =,F6.1,6H M/MIN,//,1X,20HUNITS ARE (M/SEC)**2,///, NV287
     2          8H    LINE,8X,4HREXL,11X,4HREYL,10X,7HBEXZ**2,9X,4HREXZ, NV288
     3          11X,4HREXX,10X,7HBEYZ**2,9X,4HREYZ,11X,4HREYY,/,132(1H.)/) NV289
 1220 FORMAT (4X,I3,8(5X,F10.6)/)                                       NV290
 1230 FORMAT (1H1,8HPROBLEM ,I4,36X,27HCOMPONENT VELOCITY VARIANCE//)   NV291
 1240 FORMAT (22H ASCENT RATE (M/MIN) =,8X,F6.1,22X,F6.1,22X,F6.1,22X,  NV292
     1          F6.1)                                                   NV293
 1250 FORMAT (7H0  LINE,6X,4(8X,A8,4X,A8))                              NV294
 1260 FORMAT (13X,4(19X,A9))                                            NV295
 1270 FORMAT (13X,4(8X,A9,5X,A6))                                       NV296
 1280 FORMAT (130(1H.)/)                                                NV297
 1290 FORMAT (3X,I3,10X,4(3X,F10.5,2X,F10.5,3X))                        NV298
 1300 FORMAT (1H1,8HPROBLEM ,I4,40X,22HVARIANCE IN COMPONENTS,//)       NV299
 1310 FORMAT (7H0  LINE,5X,4(10X,A6,6X,A6))                             NV300
```

```
 1320 FORMAT (13X,4(8X,A8,4X,A8))                                 NV301
 1330 FORMAT (14X,4(6X,A10,2X,A10))                               NV302
 1340 FORMAT (30H END-OF-FILE OR ERROR ON UNIT ,I2)                NV303
 1350 FORMAT (44H EXECUTION OF THE PROGRAM IS NOW TERMINATED )     NV304
      END                                                         NV305
```

```
      PROGRAM LRDC
C-
C-THIS PROGRAM COMPUTES MEAN, RMS AND SIGMA OF ANTENNA POINTING
C-ERROR DUE TO GROUND REFLECTIONS FOR RAWIN/RADAR TRACKING SYSTEMS
C-USING VERTICAL POLARIZATION ON BOTH TRANSMITTER AND RECEIVER.
C-RESULTING DATA ARE USED TO COMPUTE METEOROLOGICAL MEASUREMENT ERRORS
C-WHICH ARE PROVIDED TO TRASANA, MIRADCOM AND OTHERS. THESE DATA ARE
C-USED IN COEAS FOR 'FAMAS' AND OTHER SYSTEMS.
C-THESE RESULTS ARE ALSO USED BY MIRADCOM IN THE GSRS PROGRAM.
C-THE PROGRAM INPUTS ANTENNA BEAM PATTERN (FILE 102), SURFACE DIELECTRIC
C-CONSTANT(DC), SQUINT ANGLE(SQA) AND LOWER BEAM REDUCTION FACTOR(B).
C-IT PREPARES DISK FILE 103 AND PRINTOUT OF ELEVATION ANGLE ERRORS
C-TO INPUT FINAL SYSTEM ERROR PROGRAMS(RAWIN OR RADAR).
C-FILE 105 = INPUT, FILE 106 = PRINTER OUTPUT
C-FILE 102 = AV, UNIT = DISK
C-FILE 103 = AD,UNIT = DISK
      DOUBLE PRECISION S2EL
      DIMENSION ELAV(271),RMS(271),SIGMA(271),AV(1080),DAV(1080),
     1          DAVO(1080),V(4),DV(4),A(4),TI(1080)
      DATA 102,103,105,106/2,3,5,6/
C-
C-
C-********** BEGIN PROGRAM, ENTER CONTROL DATA FROM REMOTES ************
C-
C-1
      READ (105,210) AS,DC,SQA,B
      ZERO=541.-1.5*SQA
      P=3.14159265
C-
C-******************** ENTER DATA FROM DISK FILES *********************
C-
C-2
      READ (102,210)(TI(I),AV(I),DAV(I),DAVO(I),I=1,1080)
C-
C-********************** BEGIN ERROR COMPUTATIONS *********************
C-
C-3
      IDC=0
      E0=0.
   10 DO 110 I2=1,271
C-4
      T=1.*(I2-1)
      EL=T*P/540.
      SEL=SIN(EL)
      S2EL=SEL*SEL
      R=0.
      IF (DC.EQ.1..OR.IDC.EQ.0) GO TO 20
      C2EL=1.-S2EL
      IF (I2.EQ.1) S2EL=1.0D-46
      S2EL=P/(180.*S2EL)
```

```
      DCSEL=DC*SEL                                                      LR051
      SQ=SQRT(DC-C2EL)                                                  LR052
      R=(DCSEL-SQ)/(DCSEL+SQ)                                           LR053
   20 SE=0.                                                             LR054
      SE2=0.                                                            LR055
      E=-.001                                                           LR056
C-5                                                                     LR057
       DO 100 I3=1,40                                                   LR058
C-6                                                                     LR059
       IF (ABS(E).GT.5.) E=-.001                                        LR060
       G=(I3-1)*P/20.                                                   LR061
       CG2R=2.*R*COS(G)                                                 LR062
       I4=1                                                             LR063
C-7                                                                     LR064
   30  A(1)=ZERO-E                                                      LR065
       A(2)=ZERO-E-2*T                                                  LR066
       A(3)=ZERO+E                                                      LR067
       A(4)=ZERO+E+2*T                                                  LR068
C-8                                                                     LR069
        DO 60 I=1,4                                                     LR070
        AI=A(I)                                                         LR071
        IV=INT(AI)                                                      LR072
        AA=1.*IV                                                        LR073
        IF (IV.LT.1) IV=IV+1080                                         LR074
        IF (IV.GT.1080) IV=IV-1080                                      LR075
        IF (AA.EQ.AI) GO TO 40                                          LR076
C-9                                                                     LR077
        IV1=1+IV                                                        LR078
        IF (IV1.GT.1080) IV1=IV1-1080                                   LR079
        V(I)=AV(IV)+(AI-AA)*(AV(IV1)-AV(IV))                            LR080
        DV(I)=DAV(IV)                                                   LR081
        GO TO 50                                                        LR082
C-10                                                                    LR083
   40   V(I)=AV(IV)                                                     LR084
        DV(I)=DAVO(IV)                                                  LR085
C-11                                                                    LR086
   50   IF (I.LE.2) GO TO 60                                            LR087
        DV(I)=-B*DV(I)                                                  LR088
        V(I)=B*V(I)                                                     LR089
   60   CONTINUE                                                        LR090
      SUMV=V(1)**2+V(1)*V(2)*CG2R+(R*V(2))**2-V(3)**2-V(3)*V(4)*CG2R-   LR091
     1      (R*V(4))**2                                                 LR092
      SUMDV=2.*V(1)*DV(1)+CG2R*(DV(1)*V(2)+V(1)*DV(2))+2.*V(2)*DV(2)*   LR093
     1      R**2-2.*V(3)*[illegible]G2R*(V(3)*DV(4)+DV(3)*V(4))-2.*V(4)*    LR094
     2      DV(4)*R**2                                                  LR095
      IF (SUMDV.NE.0.) GO TO [illegible]                                LR096
      SUMDV=.00000001                                                   LR097
C-12                                                                    LR098
   70 DE=SUMV/SUMDV                                                     LR099
      ADE=ABS(DE)                                                       LR100
```

```
           IF (ADE.LT..0001) GO TO 80
           IF (ADE.GT..5) DE=.5*DE/ADE
           E=E+DE
           I4=1+I4
           IF (I4.LE.40) GO TO 30
   80      IF (IDC.EQ.1) GO TO 90
           EU=E+DE
           IDC=1
           GO TO 10
   90      E=E+DE-EO
           SE=SE+E
           SE2=SE2+E**2
  100      CONTINUE
         ELAV(I2)=(SE/40.)/3.
         RMS(I2)=SQRT(SE2/40.)/3.
         SIG=SE2-(SE**2)/40.
         IF (SIG.LE.0.) SIG=0.
         SIGMA(I2)=SQRT(SIG/39.)/3.
         T(I2)=T/3.
         WRITE (106,240) T(I2),ELAV(I2),SIGMA(I2),RMS(I2),I4
C-
  110 CONTINUE
C-
C-************************* OUTPUT ERROR DATA ************************
C-13
         EO=EO/3.
         WRITE (103,220) AS,DC,SQA,B,EO
         WRITE (103,230)
         WRITE (103,240)(T(I),ELAV(I),SIGMA(I),RMS(I),I,I=1,27)
C-
         GO TO 120
C-
C-****************************** FORMATS ******************************
C-
C-
C-***************************** COMMENTS ******************************
C-
C-1 INPUT ANTENNA SIZE, SURFACE DIELECTRIC CONSTANT, SQUINT ANGLE,
C- AND LOWER BEAM REDUCTION FACTOR.
C-2 LOADS ANTENNA BEAM VOLTAGE AT 1/3 DEGREE STEPS UPWARD FROM
C- CROSSOVER ON UPPER BEAM(DOWNWARD ON LOWER BEAM AND VOLTAGE
C- DERIVATIVES FROM PROGRAM CONVA.
C-3 12 INCREMENTS TRUE TARGET ANGLE T ABOVE BASE ANGLE IO IN
C- 1/3 DEGREE STEPS.
C-18 COMPUTE REFLECTION COEFFICIENT,R, FOR EACH
C- ELEVATION ANGLE PER TERMAN P699(VERTICAL POLARIZATION).
C- SURFACE DIELECTRIC CONSTANT AND COMPUTE K AS FUNCTION OF ELEVATION.
C-5 13 ROTATES PHASE OF REFLECTED SIGNAL G IN 40 STEPS.
C-6 INITIALIZE ERROR AND INTERATION COUNTER I4.
C-7 DEFINE UPPER AND LOWER, DIRECT AND REFLECTED ANGLES WITH ERROR.
```

```
C- A(1)IS DIRECT UPPER BEAM RAY, A(2) IS REFLECTED UPPER BEAM RAY,        LR151
C- A(3) IS DIRECT LOWER BEAM RAY, A(4) IS REFLECTED LOWER BEAM RAY.       LR152
C-8 COMPUTE SUM OF SIGNALS AND DERIVATIVES.                               LR153
C-9 COMPUTE DIRECT AND REFLECTED VOLTAGES AND DERIVATIVES IF ANGLE        LR154
C- IS NOT ON AN INPUT DATA POINT.                                         LR155
C-10 COMPUTE VOLTAGES AND DERIVATIVES IF ANGLE IS ON INPUT VALUE.         LR156
C-11 REVERSE SIGN OF DERIVATIVE FOR LOWER BEAM AND MULTIPLY BOTH          LR157
C- VOLTAGES AND DERIVATIVES BY LOWER BEAM REDUCTION FACTOR.               LR158
C-12 COMPUTE ANGLE INCREMENT WHICH WOULD REDUCE DIFFERENCE VOLTAGE        LR159
C- TO ZERO.                                                               LR160
C-13 OUTPUT INPUT DATA, OFFSET ANGLE RESULTING FROM LOWER BEAM REDUCTION  LR161
C- FACTOR, ELEVATION ANGLE, MEAN ERROR, SIGMA OF ERROR, RMS ERROR,        LR162
C- AND MEAN, SIGMA, AND RMS ERRORS PER UNIT BALLOON HEIGHT.               LR163
C-                                                                        LR164
C-************************** PROGRAM END **************************       LR165
C-                                                                        LR166
  120 STOP                                                                LR167
C                                                                         LR168
  210 FORMAT ()                                                           LR169
  220 FORMAT (1H ,16HANTENNA DIAMETER,F16.2,/,19HDIELECTRIC CONSTANT,     LR170
     1         F14.2,/,21HSQUINT ANGLE, DEGREES,F12.2,/,11HLOWER BEAM     LR171
     2         9HREDUCTION,/H FACTOR,F6.2,/,25HELEVATION OFFSET, DEGREES, LR172
     3         F12.6,/)                                                   LR173
  230 FORMAT (9HELEVATION,6X,4HMEAN,11X,5HSIGMA,10X,3HRMS,/,10(6H......)  LR174
     1        )                                                           LR175
  240 FORMAT (1X,F7.2,3F15.8,I5)                                          LR176
      END                                                                 LR177
```

8106*INPUTFILES AR

```
1      300.
2      400.
3      500.
```

8106•INPUTFILES ZHHE

1	200.,	1.2,	1.2
2	500.,	1.3,	1.3
3	1000.,	1.3,	1.3
4	1500.,	1.5,	1.5
5	2000.,	1.6,	1.6
6	3000.,	1.8,	1.8
7	4000.,	2.2,	2.2
8	5000.,	2.4,	2.4
9	6000.,	2.7,	2.7
10	8000.,	3.3,	3.3
11	10000.,	4.1,	4.1
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13	14000.,	5.9,	5.9
14	16000.,	7.2,	7.2
15	18000.,	8.3,	8.3

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3	18.21, 6.46
4	23.66, 5.07
5	28.62, 3.90
6	32.82, 3.29
7	35.77, 4.48
8	37.14, 4.95
9	38.11, 5.24
10	38.83, 4.75
11	40.43, 3.21
12	42.90, 3.19
13	44.32, 3.35
14	39.40, 1.33
15	32.86, -.76
16	32.86, -.76
17	32.86, -.76

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4	3340.	3480.	16.66	63.99
5	5720.	5910.	14.68	69.83
6	8560.	8790.	13.11	73.99
7	15100.	15390.	11.17	78.47
8	22290.	22660.	10.07	79.88
9	29780.	30210.	9.39	80.82
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11	53110.	53740.	8.32	81.49
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13	86490.	87390.	7.50	83.08
14	104250.	105290.	7.17	83.53
15	119980.	121170.	7.05	84.12
16	133030.	134400.	7.10	84.83
17	100.	100.	0.00	40.90
18	430.	480.	24.81	46.54
19	1100.	1210.	24.45	54.92
20	2530.	2720.	21.58	63.77
21	4310.	4560.	19.17	69.67
22	6440.	6750.	17.22	73.87
23	11340.	11730.	14.76	78.39
24	16740.	17220.	13.36	79.83
25	22350.	22920.	12.50	80.48
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27	39850.	40670.	11.16	81.47
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30	78200.	79530.	9.79	83.51
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32	99790.	101530.	9.76	84.82
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35	900.	1030.	29.11	54.61
36	2040.	2270.	26.12	63.55
37	3470.	3780.	23.39	69.51
38	5170.	5540.	21.13	73.75
39	9090.	9570.	18.27	78.31
40	13410.	13990.	16.55	79.78
41	17900.	18590.	15.52	80.44
42	22510.	23310.	14.82	80.79
43	31900.	32900.	13.93	81.45
44	41610.	42830.	13.32	82.39
45	51920.	53340.	12.77	83.05
46	62580.	64190.	12.32	83.50
47	72010.	73860.	12.19	84.10
48	79850.	81950.	12.33	84.81

ANTENNA DIAMETER	7.00
DIELECTRIC CONSTANT	12.00
SQUINT ANGLE, DEGREES	.00
LOWER BEAM REDUCTION FACTOR	1.00
ELEVATION OFFSET, DEGREES	-.000000

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1.00	-.70133946	.91800281	1.14609684	4
1.33	-.78821335	1.10235050	1.34390384	5
1.67	-.45962097	1.30052033	1.36393574	6
2.00	-.51226228	1.34686168	1.42516598	7
2.33	-.53748997	1.37203676	1.45750409	8
2.67	-.52984440	1.34049395	1.42574051	9
3.00	-.47979036	1.21692938	1.29386744	10
3.33	-.43031228	1.03246802	1.10657540	11
3.67	-.38734644	.82120866	.89864416	12
4.00	-.30793107	.59918012	.66698048	13
4.33	-.05111556	.12356417	.13228455	14
4.67	.03623710	.11551907	.11968362	15
5.00	.03662543	.21398728	.21444629	16
5.33	.01439036	.22549750	.22312548	17
5.67	.00811529	.19653448	.19423185	18
6.00	.00516230	.15686404	.15497683	19
6.33	.00602480	.12168825	.12030847	20
6.67	.00604031	.10091395	.09982745	21
7.00	.00573689	.08962219	.08868058	22
7.33	.00467975	.08209899	.08120122	23
7.67	.00364988	.07357550	.07274161	24
8.00	.00242165	.06342540	.06267437	25
8.33	.00133899	.04893478	.04833777	26
8.67	.00077377	.03324908	.03283995	27
9.00	.00043902	.02054844	.02029471	28
9.33	.00018636	.00955375	.00943541	29
9.67	.00001345	.00071670	.00070782	30
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10.67	-.00011825	.00712511	.00703648	33
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11.33	-.00008463	.00611620	.00603986	35
11.67	-.00005065	.00396826	.00391867	36
12.00	-.00001219	.00101045	.00099781	37
12.33	.00001831	.00196297	.00193836	38
12.67	.00001534	.00297976	.00294232	39
13.00	.00000625	.00214015	.00211323	40
13.33	.00000140	.00072763	.00071848	41
13.67	-.00000100	.00060203	.00059446	42

51	14.00	-.00000269	.00112529	.00111114	43
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53	14.67	-.00000080	.00024205	.00023901	45
54	15.00	.00000228	.00070769	.00069879	46
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56	15.67	.00000120	.00107265	.00105915	48
57	16.00	.00000020	.00033090	.00032674	49
58	16.33	.00000014	.00085346	.00084273	50
59	16.67	.00000069	.00193296	.00190864	51
60	17.00	.00000036	.00259138	.00255878	52
61	17.33	.00000029	.00284596	.00281016	53
62	17.67	.00000031	.00262345	.00259045	54
63	18.00	.00000107	.00227409	.00224548	55
64	18.33	.00000198	.00207699	.00205086	56
65	18.67	.00000269	.00205382	.00202799	57
66	19.00	.00000321	.00222278	.00219483	58
67	19.33	.00000217	.00230049	.00227155	59
68	19.67	.00000087	.00195166	.00192711	60
69	20.00	.00000054	.00122363	.00120823	61
70	20.33	.00000065	.00057093	.00056374	62
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82	24.33	.00006441	.00482744	.00476715	74
83	24.67	.00008902	.00740953	.00731687	75
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92	27.67	-.00004034	.01634106	.01613555	84
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96	29.00	-.00012599	.00727778	.00718734	88
97	29.33	-.00006344	.00360395	.00355918	89
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113	34.67	.00005480	.00578406	.00571157	105
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117	36.00	.00006538	.00620584	.00612813	109
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225	72.00	.00000028	.00000357	.00000353	217
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234	75.00	.00003645	.00754204	.00744725	226
235	75.33	.00002250	.00614253	.00606530	227
236	75.67	.00001553	.00456884	.00451139	228
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239	76.67	.00000333	.00080845	.00079829	231
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255	82.00	.00000431	.00110788	.00109395	247
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257	82.67	.00000180	.00028895	.00028532	249
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259	83.33	.00000153	.00028910	.00028547	251
260	83.67	.00000131	.00021810	.00021536	252
261	84.00	.00000193	.00036053	.00035600	253
262	84.33	.00000160	.00028959	.00028596	254
263	84.67	.00000176	.00028956	.00028592	255
264	85.00	.00000148	.00028977	.00028613	256
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272	87.67	.00000811	.00188133	.00185768	264
273	88.00	.00000432	.00119052	.00117555	265
274	88.33	-.00000055	.00030265	.00029884	266
275	88.67	-.00000561	.00135822	.00134114	267
276	8[illegible].00	-.00000655	.00144495	.00142678	268
277	89.33	-.00000689	.00202893	.00200342	269
278	89.67	-.00002063	.00246170	.00243082	270
279	90.00	.00000128	.00000074	.00000147	271

***** PROGRAM RAWIN *****

EXAMPLE RAWIN RUN USING 15 ZONES AND 3 ASCENT RATES

USE INPUT FILES AR, ZHHE, WF, UV, HPE, AD712

ARRAY W
(1/METER)

LINE	W0	ZONE 1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6	7	8	9	10
1	-.500-002	.500-002	.000	.000	.000	.000	.000	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
2	-.100-002	-.167-002	.267-002	.000	.000	.000	.000	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
3	-.450-003	-.183-003	-.867-003	.144-002	.000	.000	.000	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
4	-.300-003	-.100-003	-.120-003	-.600-003	.112-002	.000	.000	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
5	-.200-003	-.667-004	-.333-004	-.100-003	-.660-003	.106-002	.000	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
6	-.150-003	-.167-004	.667-005	-.200-004	-.600-004	-.390-003	.630-003	.000	.000	.000	.000
		.000	.000	.000	.000	.000					
7	-.100-003	.000	-.400-004	.000	-.200-004	-.400-004	-.330-003	.570-003	.000	.000	.000
		.000	.000	.000	.000	.000					
8	-.100-003	.373-004	-.533-004	.000	.000	-.200-004	-.500-004	-.260-003	.450-003	.000	.000
		.000	.000	.000	.000	.000					
9	-.100-003	.333-004	-.333-004	.000	.000	-.200-004	-.100-004	-.700-004	-.160-003	.160-003	.000
		.000	.000	.000	.000	.000					
10	-.500-004	-.167-004	.267-004	-.400-004	.200-004	-.100-004	-.100-004	-.100-004	.000	-.195-003	.275-003
		.000	.000	.000	.000	.000					
11	.000	.000	-.200-004	-.600-004	.200-004	-.200-004	.000	-.100-004	.000	-.100-004	-.200-004
		.190-003	.000	.000	.000	.000					
12	.000	-.333-004	.133-004	-.200-004	-.400-004	.100-004	.000	.000	-.100-004	-.500-005	.500-005
		-.700-004	.150-003	.000	.000	.000					
13	.000	-.373-004	.133-004	.000	-.400-004	-.100-004	.000	.000	.000	-.500-005	.500-005
		.500-005	-.550-004	.120-003	.000	.000					
14	.000	-.373-004	.133-004	.000	-.200-004	-.300-004	.000	.000	.000	.500-005	.000
		.000	.150-004	-.400-004	.900-004	.000					
15	.000	-.333-004	.133-004	.000	-.200-004	-.300-004	.000	.000	.000	.100-004	.000
		.500-005	.500-005	.100-004	-.300-004	.700-004					

ARRAY WU
(1/SEC)

ZONE

LINE	1	2	3	4	5	6	7	8	9	10
1	-.414-001	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.264-001	-.347-001	.000	.000	.000	.000	.000	.000	.000	.000
3	.452-002	.180-001	-.262-001	.000	.000	.000	.000	.000	.000	.000
4	.272-002	.426-002	.170-001	-.265-001	.000	.000	.000	.000	.000	.000
5	.182-002	.199-002	.400-002	.209-001	-.303-001	.000	.000	.000	.000	.000
6	.928-003	.744-003	.135-002	.261-002	.138-001	-.207-001	.000	.000	.000	.000
7	.474-003	.125-002	.763-003	.127-002	.198-002	.124-001	-.190-001	.000	.000	.000
8	.400-004	.132-002	.654-003	.595-003	.116-002	.220-002	.992-002	-.167-001	.000	.000
9	.400-004	.953-003	.545-003	.496-003	.108-002	.712-003	.278-002	.629-002	-.137-001	.000
10	.454-003	-.140-003	.116-002	-.176-003	.580-003	.564-003	.481-003	.873-004	.725-002	-.107-0
11	.000	.364-003	.153-002	-.176-003	.908-003	.236-003	.481-003	.873-004	.453-003	.380-0
12	.434-003	-.698-004	.582-003	.134-002	.780-005	.206-003	.959-004	.449-003	.252-003	-.641-0
13	.434-003	-.698-004	.109-003	.124-002	.580-003	.206-003	.959-004	.679-004	.245-003	-.821-0
14	.434-003	-.698-004	.109-003	.672-003	.115-002	.206-003	.959-004	.679-004	-.144-003	.104-0
15	.434-003	-.698-004	.109-003	.672-003	.115-002	.206-003	.959-004	.679-004	-.338-003	.940-0

LINE	11	12	13	14	15
1	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000
4	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	.000
6	.000	.000	.000	.000	.000
7	.000	.000	.000	.000	.000
8	.000	.000	.000	.000	.000
9	.000	.000	.000	.000	.000
10	.000	.000	.000	.000	.000
11	-.768-002	.000	.000	.000	.000
12	.320-002	-.643-002	.000	.000	.000
13	-.416-004	.253-002	-.532-002	.000	.000
14	.161-003	-.573-003	.173-002	-.355-002	.000
15	-.663-004	-.144-003	-.640-003	.724-003	-.230-002

ARRAY WV
(1/SEC)

LINE	ZONE 1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6	7	8	9	10
1	-.370-001	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
2	.124-001	-.198-001	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
3	.138-002	.460-002	-.970-002	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
4	.752-003	.387-003	.232-002	-.568-002	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
5	.501-003	-.433-004	.900-004	.211-002	-.413-002	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
6	.128-003	-.205-003	-.121-003	.234-004	.114-002	-.207-002	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
7	.300-005	.161-003	-.195-003	-.858-004	.340-004	.172-002	-.237-002	.000	.000	.000
	.000	.000	.000	.000	.000					
8	-.245-003	.280-003	-.167-003	-.140-003	-.740-005	.391-003	.138-002	-.223-002	.000	.000
	.000	.000	.000	.000	.000					
9	-.245-003	.151-003	-.179-003	-.117-003	.480-005	.188-003	.408-003	.696-003	-.189-002	.000
	.000	.000	.000	.000	.000					
10	.125-003	-.237-003	.147-003	-.172-003	-.370-005	.128-003	.871-004	.261-004	.835-003	-.131-0
	.000	.000	.000	.000	.000					
11	.000	.129-003	.276-003	-.172-003	.292-004	.952-004	.871-004	.261-004	.340-005	.135-0
	-.610-003	.000	.000	.000	.000					
12	.248-003	-.118-003	.776-004	.109-003	-.817-004	.833-004	.329-004	.727-004	-.155-004	-.147-0
	.222-003	-.478-003	.000	.000	.000					
13	.248-003	-.118-003	-.278-004	.133-003	-.370-005	.833-004	.329-004	.203-004	-.106-004	-.132-0
	-.173-004	.195-003	-.402-003	.000	.000					
14	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.580-004	-.100-
	-.130-005	-.399-004	-.478-004	-.120-003	.000					
15	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.818-004	-.924-0
	-.171-004	-.795-005	-.114-003	-.106-003	.532-004					

PARTIAL DERIVATIVES
ASCENT RATE = 300.0 M/MIN

ZONE	DXDZ	DYDZ	DXDE (M/RAD)	DYDE (M/RAD)	DXDA (M/RAD)	DYDA (M/RAD)
1	.199436+001	.165823+001	-.122547+004	-.114757+004	.371806+003	-.397043+003
2	.235595+001	.163499+001	-.379087+004	-.263080+004	.817920+003	-.117659+004
3	.299701+001	.146239+001	-.109041+005	-.532065+004	.146385+004	-.300000+004
4	.356920+001	.131109+001	-.218069+005	-.801041+004	.197043+004	-.536414+004
5	.410106+001	.117673+001	-.370355+005	-.106268+005	.23610[illegible]+004	-.822662+004
6	.469865+001	.999314+000	-.769017+005	-.156878+005	.301724+004	-.147905+005
7	.542955+001	.969105+000	-.125001+006	-.223112+005	.391669+004	-.219478+005
8	.579642+001	.936739+000	-.177691+006	-.287144+005	.475272+004	-.294092+005
9	.638879+001	.102789+001	-.259433+006	-.417402+005	.630025+004	-.391587+005
10	.638215+001	.954958+000	-.347153+006	-.519443+005	.786115+004	-.525374+005
11	.661169+001	.879838+000	-.468620+006	-.623608+005	.914476+004	-.687197+005
12	.681028+001	.826547+000	-.601671+006	-.730233+005	.104241+005	-.858884+005
13	.695962+001	.789258+000	-.740365+006	-.839613+005	.117493+005	-.103605+006
14	.694708+001	.715460+000	-.850128+006	-.875523+005	.122865+005	-.119101+006
15	.661110+001	.616263+000	-.924894+006	-.836837+005	.119825+005	-.112474+006

PARTIAL DERIVATIVES
ASCENT RATE = 400.0 M/MIN

ZONE	DXDZ	DYDZ	DXDF (M/RAD)	DYDF (M/RAD)	DXDA (M/RAD)	DYDA (M/RAD)
1	.156984+001	.148765+001	-.824598+003	-.781421+003	.297653+003	-.314100+003
2	.179890+001	.124335+001	-.238720+004	-.167651+004	.631355+003	-.899706+003
3	.226496+001	.111597+001	-.662011+004	-.324181+004	.111669+004	-.226641+004
4	.269077+001	.996948+000	-.130037+005	-.481794+004	.149723+004	-.404103+004
5	.308746+001	.892902+000	-.218090+005	-.630721+004	.179928+004	-.618696+004
6	.368949+001	.758015+000	-.447979+005	-.920383+004	.228279+004	-.111110+005
7	.409397+001	.734408+000	-.724873+005	-.130034+005	.295566+004	-.164764+005
8	.437243+001	.733262 000	-.102729+006	-.172278+005	.369800+004	-.220511+005
9	.457611+001	.739709+000	-.134688+006	-.217424+005	.449236+004	-.277671+005
10	.484667+001	.726934+000	-.201255+006	-.301854+005	.591363+004	-.394278+005
11	.504073+001	.672577+000	-.272304+006	-.363331+005	.687947+004	-.515592+005
12	.521212+001	.634428+000	-.350290+006	-.426379+005	.783751+004	-.643887+005
13	.535280+001	.608928+000	-.432829+006	-.492381+005	.883669+004	-.774792+005
14	.536947+001	.553934+000	-.499903+006	-.515718+005	.923876+004	-.895544+005
15	.527731+001	.478415+000	-.545353+006	-.494391+005	.901124+004	-.954012+005

PARTIAL DERIVATIVES
ASCENT RATE = 500.0 M/MIN

ZONE	DXDZ	DYDZ	DXDE (M/RAD)	DYDE (M/RAD)	DXDA (M/RAD)	DYDA (M/RAD)
1	.131953+001	.126362+001	-.624788+003	-.600228+003	.252771+003	-.263956+003
2	.146348+001	.103965+001	-.172161+004	-.122304+004	.519916+003	-.731844+003
3	.182421+001	.907529+000	-.461410+004	-.229548+004	.907950+003	-.182505+004
4	.216196+001	.807695+000	-.889669+004	-.332457+004	.121287+004	-.324549+004
5	.247740+001	.722095+000	-.147255+005	-.429210+004	.144621+004	-.496171+004
6	.295931+001	.612304+000	-.298427+005	-.617470+004	.184174+004	-.890127+004
7	.328436+001	.592134+000	-.479747+005	-.864931+004	.237842+004	-.131923+005
8	.350993+001	.591140+000	-.677812+005	-.114157+005	.297293+004	-.176520+005
9	.367473+001	.555834+000	-.886591+005	-.143755+005	.360213+004	-.222156+005
10	.389873+001	.584086+000	-.132305+006	-.198911+005	.474144+004	-.315374+005
11	.406149+001	.542639+000	-.178978+006	-.239126+005	.550877+004	-.412314+005
12	.421205+001	.513444+000	-.230763+006	-.281297+005	.628180+004	-.515329+005
13	.433471+001	.493878+000	-.285346+006	-.325111+005	.708163+004	-.621547+005
14	.435405+001	.449947+000	-.329758+006	-.340772+005	.740093+004	-.716173+005
15	.428521+001	.389231+000	-.360454+006	-.327405+005	.722136+004	-.795071+005

PROBLEM 1

WIND ERROR INPUT
ASSUMED ONE SIGMA ERRORS

EXAMPLE RAWIN PROBLEM

```
ELEVATION BIAS ERROR (DEGREES) =    .03      ELEVATION RANDOM ERR (DEGREES) =    .05
AZIMUTH BIAS ERROR   (DEGREES) =    .03      AZIMUTH RANDOM ERROR (DEGREES) =    .05
DISPL. LAUNCH ERROR  (METERS)  =   5.00      AZIMUTH LAUNCH ERROR (METERS)  =    .00
FOREGROUND ELEVATION (DEGREES) =   5.00
```

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 300.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	BEXZ**2 REXZ	BELXE**2 RELXE	BEPXF**2 REPXF	BEXA**2 REXA	BEYZ**2 REYZ	BELYE**2 RELYE	BEPYF**2 REPYF	BEYA**2 REYA
1	BIAS			.000097	.000257	.000000	.000024	.000129	.000226	.000000	.000027
	RANDOM	.006698	.008927	.000097	.000715	.000000	.000066	.000129	.000627	.000000	.000075
2	BIAS			.000058	.000446	.000000	.000017	.000001	.000178	.000000	.000042
	RANDOM	.000268	.000357	.000160	.002025	.000001	.000098	.000020	.001007	.000000	.000196
3	BIAS			.000068	.001057	.000000	.000013	.000002	.000195	.000000	.000074
	RANDOM	.000054	.000072	.000168	.004873	.000030	.000093	.000009	.001204	.000007	.000373
4	BIAS			.000042	.002052	.000000	.000010	.000001	.000196	.000000	.000111
	RANDOM	.000024	.000032	.000223	.012176	.000009	.000108	.000014	.001729	.000002	.000749
5	BIAS			.000044	.003807	.000050	.000007	.000002	.000191	.000004	.000159
	RANDOM	.000011	.000014	.000392	.033306	.040364	.000152	.000023	.002954	.003323	.001689
6	BIAS			.000030	.007232	.000445	.000005	.000001	.000182	.000017	.000225
	RANDOM	.000004	.000008	.000185	.048693	.350453	.000085	.000008	.002191	.014807	.001851
7	BIAS			.000012	.010320	.029611	.000006	.000000	.000243	.000922	.000269
	RANDOM	.000003	.000004	.000169	.095871	1.660056	.000101	.000001	.003177	.053812	.003031
8	BIAS			.000012	.012502	.119502	.000005	.000000	.000249	.003305	.000296
	RANDOM	.000003	.000004	.000124	.142117	1.105968	.000107	.000000	.003832	.031079	.003965
9	BIAS			.000020	.020449	11.229731	.000009	.000000	.000490	.291119	.000387
	RANDOM	.000003	.000004	.000059	.182937	63.596860	.000110	.000000	.004749	1.646433	.004251
10	BIAS			.000001	.013980	3.421987	.000006	.000000	.000253	.066129	.000314
	RANDOM	.000001	.000001	.000054	.217424	91.812114	.000115	.000000	.005023	2.114202	.004975
11	BIAS			.000001	.019191	6.689401	.000005	.000000	.000256	.103815	.000391
	RANDOM	.000000	.000000	.000044	.169698	103.587361	.000067	.000002	.003096	1.872407	.003677
12	BIAS			.000000	.021035	7.810244	.000004	.000000	.000249	.103971	.000402
	RANDOM	.000000	.000000	.000063	.175727	127.099808	.000055	.000001	.002653	1.911129	.003605
13	BIAS			.000000	.022504	7.021540	.000004	.000000	.000246	.084309	.000420
	RANDOM	.000000	.000000	.000059	.171336	126.574532	.000044	.000000	.002246	1.657236	.003373
14	BIAS			.000000	.021250	6.535269	.000003	.000000	.000196	.067418	.000409
	RANDOM	.000000	.000000	.000011	.129759	94.826549	.000028	.000004	.001423	1.038496	.002556
15	BIAS			.000000	.019289	6.073265	.000003	.000000	.000150	.253713	.000390
	RANDOM	.000000	.000000	.000010	.093662	68.606710	.000017	.000008	.000608	.589451	.001911

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 400.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	REXZ**2 REXZ	RELXE**2 RELXE	RERXE**2 RERXE	REXA**2 REXA	REYZ**2 REYZ	RELYE**2 RELYE	RERYE**2 RERYE	REYA**2 REYA
1	BIAS			.000172	.000207	.000000	.000027	.000228	.000186	.000000	.000070
	RANDOM	.011909	.015870	.000172	.000575	.000001	.000075	.000228	.000517	.000001	.000083
2	BIAS			.000052	.000304	.000000	.000017	.000002	.000122	.000000	.000043
	RANDOM	.000476	.000635	.000129	.001436	.000003	.000104	.000036	.000734	.000001	.000204
3	BIAS			.000065	.000677	.000000	.000013	.000002	.000125	.000000	.000075
	RANDOM	.000094	.000129	.000160	.003202	.000004	.000096	.000012	.000809	.000001	.000378
4	BIAS			.000041	.001273	.000000	.000010	.000002	.000122	.000000	.000112
	RANDOM	.000043	.000057	.000217	.007716	.000004	.000111	.000016	.001117	.000001	.000756
5	BIAS			.000043	.002300	.000000	.000007	.000002	.000115	.000000	.000159
	RANDOM	.000019	.000025	.000386	.020596	.000021	.000155	.000025	.001859	.000002	.001698
6	BIAS			.000031	.004310	.000000	.000005	.000001	.000108	.000000	.000225
	RANDOM	.000011	.000014	.000182	.029429	.000041	.000087	.000008	.001346	.000002	.001558
7	BIAS			.000013	.006118	.000034	.000006	.000000	.000144	.000001	.000249
	RANDOM	.000005	.000006	.000165	.057381	.045438	.000102	.000001	.001922	.001462	.003078
8	BIAS			.000013	.007377	.000783	.000006	.000000	.000169	.000011	.000295
	RANDOM	.000005	.000006	.000120	.084530	.186223	.000114	.000000	.002429	.005282	.003545
9	BIAS			.000009	.008263	.000581	.000007	.000000	.000187	.000015	.000312
	RANDOM	.000005	.000006	.000077	.089604	.296306	.000102	.000000	.002360	.007772	.003849
10	BIAS			.000003	.010305	.000358	.000006	.000000	.000194	.000007	.000352
	RANDOM	.000001	.000002	.000055	.124719	.884771	.000113	.000000	.002882	.020161	.004874
11	BIAS			.000001	.011658	.001529	.000005	.000000	.000156	.000025	.000383
	RANDOM	.000000	.000000	.000039	.101797	1.520253	.000068	.000002	.001867	.027476	.003679
12	BIAS			.000000	.012758	.017187	.000004	.000000	.000151	.000247	.000492
	RANDOM	.000000	.000000	.000054	.105878	2.007322	.000055	.000001	.001607	.030326	.003603
13	BIAS			.000000	.011784	.027636	.000004	.000000	.000152	.000342	.000420
	RANDOM	.000000	.000000	.000049	.103994	1.098281	.000045	.000001	.001371	.014549	.003371
14	BIAS			.000000	.013026	.015077	.000003	.000000	.000119	.000149	.000409
	RANDOM	.000000	.000000	.000008	.079624	.478606	.000028	.000004	.000876	.005385	.002559
15	BIAS			.000000	.011752	.016097	.000003	.000000	.000091	.000131	.000358
	RANDOM	.000000	.000000	.000012	.057816	.453785	.000017	.000008	.000500	.003582	.001913

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 500.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	REXZ**2 REXZ	BELXE**2 RELXE	BERXE**2 RERXE	REXA**2 REXA	REYZ**2 REYZ	BELYE**2 RELYE	BERYE**2 RERYE	REYA**2 REYA
1	BIAS			.000266	.000187	.000000	.000030	.000353	.000171	.000000	.000073
	RANDOM	.018606	.024797	.000266	.000519	.000000	.000084	.000353	.000476	.000000	.000092
2	BIAS			.000047	.000239	.000000	.000018	.000004	.000097	.000000	.000044
	RANDOM	.000744	.000992	.000103	.001172	.000004	.000111	.000056	.000615	.000002	.000212
3	BIAS			.000063	.000523	.000000	.000013	.000003	.000093	.000000	.000075
	RANDOM	.000151	.000201	.000153	.002437	.000001	.000100	.000014	.000630	.000000	.000384
4	BIAS			.000041	.000913	.000000	.000010	.000002	.000087	.000000	.000112
	RANDOM	.000067	.000089	.000213	.005659	.000009	.000114	.000017	.000835	.000001	.000763
5	BIAS			.000043	.001603	.000000	.000007	.000002	.000080	.000000	.000159
	RANDOM	.000030	.000040	.000381	.014720	.000005	.000159	.000026	.001352	.000001	.001707
6	BIAS			.000031	.002943	.000000	.000005	.000001	.000074	.000000	.000226
	RANDOM	.000017	.000022	.000179	.020453	.000011	.000098	.000008	.000951	.000000	.001863
7	BIAS			.000013	.004138	.000000	.000006	.000000	.000097	.000000	.000249
	RANDOM	.000007	.000010	.000162	.039340	.000708	.000104	.000001	.001333	.000010	.003044
8	BIAS			.000014	.004978	.000000	.000006	.000000	.000114	.000000	.000295
	RANDOM	.000007	.000010	.000118	.057552	.000995	.000115	.000000	.001669	.000029	.003970
9	BIAS			.000009	.005557	.000000	.000007	.000000	.000126	.000000	.000312
	RANDOM	.000007	.000010	.000075	.060700	.000270	.000102	.000000	.001613	.000007	.003551
10	BIAS			.000004	.006935	.000008	.000006	.000000	.000130	.000000	.000352
	RANDOM	.000002	.000002	.000053	.084257	.015132	.000114	.000000	.001956	.000342	.004573
11	BIAS			.000002	.007349	.000036	.000005	.000000	.000104	.000001	.000393
	RANDOM	.000000	.000000	.000037	.068719	.061591	.000068	.000002	.001264	.001107	.003677
12	BIAS			.000001	.008660	.000196	.000004	.000000	.000102	.000003	.000403
	RANDOM	.000000	.000000	.000050	.071772	.133967	.000055	.000001	.001092	.002014	.003605
13	BIAS			.000001	.009351	.000314	.000004	.000000	.000103	.000004	.000420
	RANDOM	.000000	.000000	.000045	.070609	.185353	.000045	.000001	.000934	.002418	.003372
14	BIAS			.000000	.008843	.000255	.000003	.000000	.000081	.000003	.000408
	RANDOM	.000000	.000000	.000006	.054127	.155648	.000028	.000004	.000598	.001711	.002558
15	BIAS			.000000	.008029	.000156	.000003	.000000	.000062	.000001	.000387
	RANDOM	.000000	.000000	.000014	.039441	.107367	.000017	.000008	.000343	.000929	.001912

PROBLEM 1

VARIANCE IN COMPONENTS

ASCENT RATE (M/MIN) =

LINE	300.0 EAST VARIANCE (M/SEC)**2	300.0 NORTH VARIANCE (M/SEC)**2	400.0 EAST VARIANCE (M/SEC)**2	400.0 NORTH VARIANCE (M/SEC)**2	500.0 EAST VARIANCE (M/SEC)**2	500.0 NORTH VARIANCE (M/SEC)**2
1	.00795	.01014	[illegible]	.01714	.01996	.02628
2	.00707	.00180	.00252	.00178	.00244	.00202
3	.00636	.00194	.00431	.00153	.00342	.00140
4	.01464	.00283	.00942	.00218	.00703	.00191
5	.07813	.00836	.02353	.00389	.01495	.00337
6	.40713	.01929	.03409	.00356	.02373	.00315
7	1.79615	.06146	.10926	.00684	.04408	.00476
8	1.38024	.04273	.27877	.01216	.06379	.00609
9	75.03017	1.94743	.39495	.01450	.06673	.00592
10	95.46568	2.19090	1.02033	.02847	.10651	.00766
11	110.46577	1.98363	1.63535	.03359	.13830	.00654
12	135.10693	2.02191	2.14322	.03634	.21456	.00722
13	137.79002	1.74783	1.23379	.02021	.26572	.00727
14	101.51287	1.11050	.58637	.00950	.21891	.00536
15	74.79296	.64643	.53948	.00691	.15501	.00364

PROBLEM 1

COMPONENT VELOCITY VARIANCE

ASCENT RATE (M/MIN) =	300.0		400.0		500.0	
LINE	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)
1	.03414	.18476	.05717	.23902	.08723	.29535
2	.00920	.09590	.00811	.09006	.00842	.09174
3	.01565	.12509	.01103	.10502	.00910	.09538
4	.03298	.18159	.02188	.14792	.01685	.12981
5	.16319	.40397	.05172	.22742	.03833	.19577
6	.80455	.89697	.07105	.26655	.05070	.22517
7	3.50482	1.87212	.21906	.46804	.09215	.30357
8	2.68477	1.63853	.54890	.74088	.13183	.36309
9	145.23654	12.05141	.77253	.87894	.13707	.37023
10	184.25233	13.57396	1.97882	1.40671	.21541	.46412
11	212.16250	14.56580	3.14885	1.77450	.27328	.52276
12	258.72613	16.08497	4.11225	2.02787	.41845	.64668
13	255.72434	15.99138	2.36597	1.53817	.51507	.71768
14	193.62336	13.91486	1.12425	1.06031	.42314	.65049
15	142.33432	11.93039	1.03090	1.01537	.29933	.54711

AD-A126 360 MODELS FOR BALLISTIC WIND MEASUREMENT ERROR ANALYSIS VOLUME II USERS' MAN..(U) NEW MEXICO STATE UNIV LAS CRUCES PHYSICAL SCIENCE LAB A W DUDENHOEFFER JAN 83 2/2

UNCLASSIFIED ERADCOM/ASL-CR-83-0008-1 DAAD07-79-C-0008 F/G 9/2 NL

END
DATE
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4-83
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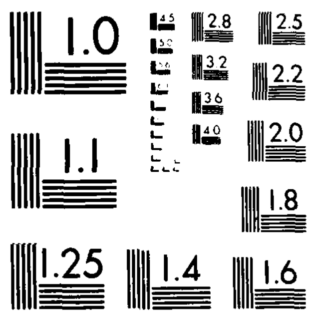

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

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***** PROGRAM RADAR *****

EXAMPLE RADAR RUN USING 15 ZONES AND 3 ASCENT RATES
USE INPUT FILES AR, ZHHE, WF, UV, HRE, AD712
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ARRAY W
(1/METER)

LINE	W0	ZONE 1 11	2 12	3 13	4 14	5 15	6	7	8	9	10
1	-.500-002	.500-002 .000	.000 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
2	-.100-002	-.167-002 .000	.267-002 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
3	-.450-003	-.183-003 .000	-.807-003 .000	.144-002 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
4	-.300-003	-.100-003 .000	-.120-003 .000	-.600-003 .000	.112-002 .000	.000 .000	.000	.000	.000	.000	.000
5	-.200-003	-.667-004 .000	-.333-004 .000	-.100-003 .000	-.660-003 .000	.106-002 .000	.000	.000	.000	.000	.000
6	-.150-003	-.167-004 .000	.667-005 .000	-.200-004 .000	-.600-004 .000	-.390-003 .000	.630-003	.000	.000	.000	.000
7	-.100-003	.000 .000	-.400-004 .000	.000 .000	-.200-004 .000	-.400-004 .000	-.330-003	.530-003	.000	.000	.000
8	-.100-003	.333-004 .000	-.533-004 .000	.000 .000	.000 .000	-.200-004 .000	-.500-004	-.260-003	.450-003	.000	.000
9	-.100-003	.333-004 .000	-.333-004 .000	.000 .000	.000 .000	-.200-004 .000	-.100-004	-.700-004	-.160-003	.360-003	.000
10	-.500-004	-.167-004 .000	.267-004 .000	-.400-004 .000	.200-004 .000	-.100-004 .000	-.100-004	-.100-004	.000	-.185-003	.275-003
11	.000	.000 .190-003	-.200-004 .000	-.600-004 .000	.200-004 .000	-.200-004 .000	.000	-.100-004	.000	-.100-004	-.900-004
12	.000	-.373-004 -.700-004	.133-004 .150-003	-.200-004 .000	-.400-004 .000	.100-004 .000	.000	.000	-.100-004	-.500-005	.500-005
13	.000	-.373-004 .500-005	.133-004 -.550-004	.000 .120-003	-.400-004 .000	-.100-004 .000	.000	.000	.000	-.500-005	.500-005
14	.000	-.373-004 .000	.133-004 .150-004	.000 -.400-004	-.200-004 .900-004	-.300-004 .000	.000	.000	.000	.500-005	.000
15	.000	-.373-004 .500-005	.133-004 .500-005	.000 .100-004	-.200-004 -.300-004	-.300-004 .700-004	.000	.000	.000	.100-004	.000

ARRAY WU
(1/SEC)

LINE	ZONE 1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6	7	8	9	10
1	-.414-001	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
2	.264-001	-.347-001	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
3	.452-002	.180-001	-.262-001	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
4	.272-002	.426-002	.170-001	-.265-001	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
5	.182-002	.199-002	.400-002	.209-001	-.303-001	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
6	.928-003	.744-003	.135-002	.261-002	.139-001	-.207-001	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
7	.474-003	.125-002	.763-003	.127-002	.198-002	.124-001	-.190-001	.000	.000	.000
	.000	.000	.000	.000	.000					
8	.400-004	.132-002	.654-003	.595-003	.116-002	.220-002	.992-002	-.167-001	.000	.000
	.000	.000	.000	.000	.000					
9	.400-004	.953-003	.545-003	.496-003	.108-002	.712-003	.278-002	.629-002	-.137-001	.000
	.000	.000	.000	.000	.000					
10	.454-003	-.140-003	.116-002	-.176-003	.580-003	.564-003	.481-003	.873-004	.725-002	-.107-00
	.000	.000	.000	.000	.000					
11	.000	.364-003	.153-002	-.176-003	.908-003	.236-003	.481-003	.873-004	.453-003	.390-00
	-.768-002	.000	.000	.000	.000					
12	.434-003	-.698-004	.582-003	.134-002	.780-005	.206-003	.959-004	.449-003	.252-003	-.651-0
	.320-002	-.643-002	.000	.000	.000					
13	.434-003	-.698-004	.109-003	.124-002	.580-003	.206-003	.959-004	.679-004	.245-003	-.821-00
	-.416-004	.253-002	-.532-002	.000	.000					
14	.434-003	-.698-004	.109-003	.672-003	.115-002	.206-003	.959-004	.679-004	-.144-003	.104-00
	.161-003	-.573-003	.133-002	-.355-002	.000					
15	.434-003	-.698-004	.109-003	.672-003	.115-002	.206-003	.959-004	.679-004	-.338-003	.940-0
	-.663-004	-.144-003	-.640-003	.724-003	-.230-002					

ARRAY WV
(1/SEC)

LINE	ZONE 1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6	7	8	9	10
1	-.370-001	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
2	.124-001	-.198-001	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
3	.138-002	.460-002	-.930-002	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
4	.752-003	.397-003	.232-002	-.568-002	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
5	.501-003	-.433-004	.900-004	.211-002	-.413-002	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
6	.128-003	-.205-003	-.121-003	.274-004	.114-002	-.207-002	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
7	.300-005	.161-003	-.195-003	-.858-004	.340-004	.172-002	-.237-002	.000	.000	.000
	.000	.000	.000	.000	.000					
8	-.245-003	.280-003	-.167-003	-.140-003	-.740-005	.391-003	.138-002	-.223-002	.000	.000
	.000	.000	.000	.000	.000					
9	-.245-003	.151-003	-.139-003	-.117-003	.480-005	.188-003	.408-003	.896-003	-.189-002	.000
	.000	.000	.000	.000	.000					
10	.125-003	-.237-003	.147-003	-.172-003	-.370-005	.128-003	.871-004	.261-004	.835-003	-.131-002
	.000	.000	.000	.000	.000					
11	.000	.129-003	.276-003	-.172-003	.292-004	.952-004	.871-004	.261-004	.340-005	.135-003
	-.610-003	.000	.000	.000	.000					
12	.248-003	-.118-003	.736-004	.109-003	-.817-004	.833-004	.329-004	.727-004	-.155-004	-.147-003
	.222-003	-.478-003	.000	.000	.000					
13	.248-003	-.118-003	-.278-004	.133-003	-.370-005	.833-004	.329-004	.203-004	-.106-004	-.132-003
	-.173-004	.195-003	-.482-003	.000	.000					
14	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.580-004	-.100-003
	-.130-005	-.399-004	-.478-004	-.120-003	.000					
15	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.818-004	-.974-004
	-.171-004	-.795-005	-.114-003	-.106-003	.532-004					

PARTIAL DERIVATIVES
ASCENT RATE = 300.0 M/MIN

ZONE	DXDZ	DYDZ	DXDE	DYDE	DXDA	DYDA	DZDS	DZDF
1	.198436+001	.185823+001	-.122547+004	-.114757+004	.371806+003	-.397043+003	.345215+000	.543951+003
2	.235895+001	.163499+001	-.379087+004	-.267080+004	.817920+003	-.117859+004	.329244+000	.143460+004
3	.299701+001	.146239+001	-.109041+005	-.532065+004	.146385+004	-.300000+004	.287194+000	.337309+004
4	.356920+001	.131109+001	-.218069+005	-.801041+004	.197043+004	-.536414+004	.254288+000	.571460+004
5	.410106+001	.117673+001	-.370355+005	-.106268+005	.236107+004	-.822862+004	.228130+000	.856066+004
6	.489865+001	.999314+000	-.769017+005	-.156878+005	.301724+004	-.147905+005	.196045+000	.150951+005
7	.542955+001	.969105+000	-.125001+006	-.223112+005	.391669+004	-.219438+005	.178295+000	.222906+005
8	.579642+001	.936739+000	-.177681+006	-.287144+005	.475272+004	-.294092+005	.167765+000	.297906+005
9	.638879+001	.102789+001	-.259433+006	-.417402+005	.630025+004	-.391587+005	.152584+000	.396620+005
10	.638215+001	.954958+000	-.347153+006	-.519443+005	.786115+004	-.525374+005	.152947+000	.531217+005
11	.661169+001	.879838+000	-.468620+006	-.623608+005	.914476+004	-.687197+005	.148041+000	.693241+005
12	.681028+001	.826547+000	-.601671+006	-.730233+005	.104241+005	-.858884+005	.143977+000	.865160+005
13	.695962+001	.789258+000	-.740365+006	-.839613+005	.117493+005	-.103605+006	.141034+000	.104264+006
14	.694708+001	.715460+000	-.850128+006	-.875523+005	.122965+005	-.119301+006	.141394+000	.119925+006
15	.681110+001	.616263+000	-.924894+006	-.836837+005	.119825+005	-.132434+006	.144284+000	.132965+006

PARTIAL DERIVATIVES
ASCENT RATE = 400.0 M/MIN

ZONE	DXDZ	DYDZ	DXDE	DYDE	DXDA	DYDA	DZDS	DZDE
1	.156984+001	.148765+001	-.624598+003	-.781421+003	.297653+003	-.314100+003	.419672+000	.432731+003
2	.179890+001	.126335+001	-.278720+004	-.167651+004	.631855+003	-.899706+003	.414056+000	.109941+004
3	.226496+001	.111597+001	-.662011+004	-.326181+004	.111660+004	-.226641+004	.368169+000	.252658+004
4	.269077+001	.969648+000	-.130037+005	-.481794+004	.149723+004	-.404103+004	.329011+000	.430943+004
5	.308746+001	.892902+000	-.218090+005	-.630721+004	.178928+004	-.618696+004	.297007+000	.644050+004
6	.368949+001	.758015+000	-.[illegible]7979+005	-.920383+004	.228279+004	-.111110+005	.256492+000	.113431+005
7	.409397+001	.734408+000	-.724873+005	-.130034+005	.295566+004	-.164764+005	.233624+000	.167394+005
8	.437243+001	.733262+000	-.102729+006	-.172278+005	.369800+004	-.220511+005	.219864+000	.223590+005
9	.457611+001	.738709+000	-.134468+006	-.217424+005	.448236+004	-.277671+005	.210693+000	.281264+005
10	.484667+001	.726934+000	-.201255+006	-.301854+005	591363+004	-.394278+005	.195685+000	.398685+005
11	.504073+001	.672577+000	-.272304+006	-.363331+005	.687947+004	-.515592+005	.192655+000	.520156+005
12	.521212+001	.634428+000	-.350290+006	-.426379+005	.783751+004	-.643887+005	.186752+000	.648629+005
13	.535280+001	.608928+000	-.432829+006	-.492381+005	.683669+004	-.776792+005	.182117+000	.781782+005
14	.536947+001	.553934+000	-.499903+006	-.515718+005	.623876+004	-.895544+005	.181714+000	.900257+005
15	.527731+001	.478415+000	-.545353+006	-.494391+005	.901124+004	-.994012+005	.184939+000	.998048+005

PARTIAL DERIVATIVES
ASCENT RATE = 500.0 M/MIN

ZONE	DXDZ	DYDZ	DXDE	DYDE	DXDA	DYDA	DZDS	DZDF
1	.131953+001	.126362+001	-.626788+003	-.600228+003	.252771+003	-.263956+003	.480121+000	.365467+003
2	.146748+001	.103965+001	-.172161+004	-.122394+004	.519916+003	-.731864+003	.496611+000	.897740+003
3	.182421+001	.907529+000	-.461410+004	-.229548+004	.907950+003	-.182505+004	.440540+000	.203843+004
4	.216196+001	.807895+000	-.889469+004	-.332457+004	.121287+004	-.324569+004	.397487+000	.346491+004
5	.247740+001	.722095+000	-.147255+005	-.429210+004	.144621+004	-.496171+004	.361242+000	.516818+004
6	.295931+001	.612304+000	-.298427+005	-.617470+004	.184174+004	-.890127+004	.314021+000	.908981+004
7	.328436+001	.592134+000	-.479747+005	-.864931+004	.237842+004	-.131923+005	.286868+000	.134050+005
8	.350993+001	.591140+000	-.677812+005	-.114157+005	.297293+004	-.176520+005	.270281+000	.179005+005
9	.367473+001	.595834+000	-.886591+005	-.147755+005	.360213+004	-.222156+005	.259197+000	.225057+005
10	.389833+001	.586088+000	-.132305+006	-.198911+005	.474144+004	-.315374+005	.245592+000	.318917+005
11	.406149+001	.542639+000	-.178978+006	-.239126+005	.550877+004	-.412314+005	.236738+000	.415975+005
12	.421205+001	.513444+000	-.230763+006	-.281297+005	.628180+004	-.515329+005	.228977+000	.519138+005
13	.433471+001	.493878+000	-.285346+006	-.325111+005	.708163+004	-.621547+005	.222954+000	.625558+005
14	.435405+001	.449947+000	-.329758+006	-.340772+005	.740093+004	-.716173+005	.222184+000	.719972+005
15	.428521+001	.389231+000	-.360454+006	-.327405+005	.722136+004	-.795031+005	.225766+000	.799283+005

```
PROBLEM    1                                    WIND ERROR INPUT
                                          ASSUMED ONE SIGMA ERRORS

EXAMPLE RADAR PROBLEM

            ELEVATION BIAS ERROR (DEGREES) =    .03      ELEVATION RANDOM ERR (DEGREES) =   .05

            AZIMUTH BIAS ERROR   (DEGREES) =    .03      AZIMUTH RANDOM ERROR (DEGREES) =   .05

            RANGE   BIAS   ERROR  (METERS)  =    .00      RANGE  RANDOM ERROR (METERS)   = 16.00

            DISPL. LAUNCH ERROR  (METERS)  =   5.00      AZIMUTH LAUNCH ERROR (METERS)  =   .00

            FOREGROUND ELEVATION (DEGREES) =   5.00
```

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 300.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	BEXS**2 REXS	BELXE**2 RELXE	BERXE**2 RERXE	BEXA**2 REXA	BEYS**2 REYS	BELYE**2 RELYE	BERYE**2 RERYE	BEYA**2 REYA
1	BIAS			.000000	.000775	.000000	.000024	.000000	.000653	.000000	.000027
	RANDOM	.006698	.008927	.319308	.007152	.000001	.000066	.290440	.001815	.000001	.000075
2	BIAS			.000000	.001574	.000000	.000017	.000000	.000610	.000000	.000042
	RANDOM	.000268	.000357	.116260	.008130	.000003	.000098	.091855	.003274	.000001	.000196
3	BIAS			.000000	.004039	.000000	.000013	.000000	.000695	.000000	.000074
	RANDOM	.000054	.000072	.053822	.022291	.000134	.000093	.022801	.003892	.000024	.000373
4	BIAS			.000000	.008254	.000000	.000010	.000000	.000699	.000000	.000111
	RANDOM	.000024	.000032	.049242	.063152	.000057	.000108	.012752	.004983	.000004	.000749
5	BIAS			.000000	.015931	.000269	.000007	.000000	.000665	.000011	.000159
	RANDOM	.000011	.000014	.066954	.186482	.217838	.000152	.011052	.007539	.008812	.001689
6	BIAS			.000000	.030831	.002241	.000005	.000000	.000626	.000046	.000225
	RANDOM	.000006	.000008	.039229	.262021	1.844705	.000085	.003035	.005671	.039263	.001651
7	BIAS			.000000	.044017	.151219	.000006	.000000	.000904	.003288	.000269
	RANDOM	.000003	.000004	.039258	.508372	8.686936	.000101	.001658	.011610	.194888	.003031
8	BIAS			.000000	.053010	.620512	.000005	.000000	.001022	.013771	.000296
	RANDOM	.000003	.000004	.034220	.727952	5.780278	.000107	.001089	.015851	.129790	.003965
9	BIAS			.000000	.060508	52.548163	.000009	.000000	.001731	1.156321	.000387
	RANDOM	.000003	.000004	.026493	.870108	208.256569	.000110	.000765	.019232	6.560567	.004251
10	BIAS			.000000	.062076	16.256746	.000006	.000000	.001081	.290852	.000314
	RANDOM	.000001	.000001	.019042	1.043244	440.389920	.000115	.000518	.019035	8.028242	.004975
11	BIAS			.000000	.082347	30.805093	.000005	.000000	.001020	.402125	.000381
	RANDOM	.000000	.000000	.008236	.826716	503.115532	.000067	.000228	.008581	5.275267	.003677
12	BIAS			.000000	.091250	76.057017	.000004	.000000	.000997	.406105	.000402
	RANDOM	.000000	.000000	.005428	.887986	641.198914	.000055	.000130	.008177	5.875893	.003605
13	BIAS			.000000	.098643	32.271132	.000004	.000000	.001002	.341067	.000420
	RANDOM	.000000	.000000	.003658	.872753	644.754814	.000044	.000083	.007590	5.587165	.003373
14	BIAS			.000000	.092891	70.042880	.000003	.000000	.000793	.275254	.000409
	RANDOM	.000000	.000000	.002241	.566846	414.060524	.000028	.000056	.002404	1.741392	.002556
15	BIAS			.000000	.084389	27.922839	.000003	.000000	.000622	.220316	.000390
	RANDOM	.000000	.000000	.001406	.746576	253.838074	.000017	.000042	.000631	.445535	.001911

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 400.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	BEXS**2 REXS	BELXE**2 RELXE	BERXE**2 RERXE	BEXA**2 REXA	BEYS**2 REYS	BELYE**2 RELYE	BERYE**2 RERYE	BEYA**2 REYA
1	BIAS			.000000	.000565	.000000	.000027	.000000	.000485	.000000	.000030
	RANDOM	.011908	.015870	.312771	.001570	.000002	.000075	.296987	.001347	.000001	.000063
2	BIAS			.000000	.000987	.000000	.000017	.000000	.000386	.000000	.000043
	RANDOM	.000476	.000635	.099650	.005272	.000010	.000104	.084830	.002177	.000004	.000204
3	BIAS			.000000	.002435	.000000	.000013	.000000	.000421	.000000	.000075
	RANDOM	.000096	.000129	.038689	.013646	.000016	.000096	.020117	.002441	.000003	.000378
4	BIAS			.000000	.004883	.000000	.000010	.000000	.000415	.000000	.000112
	RANDOM	.000043	.000057	.035132	.037713	.000019	.000111	.011597	.003058	.000002	.000756
5	BIAS			.000000	.009276	.000000	.000007	.000000	.000388	.000000	.000159
	RANDOM	.000019	.000025	.048369	.109686	.000108	.000155	.010309	.004563	.000004	.001698
6	BIAS			.000000	.017844	.000000	.000005	.000000	.000364	.000000	.000225
	RANDOM	.000011	.000014	.030614	.152433	.000209	.000087	.002860	.003375	.000005	.001658
7	BIAS			.000000	.025402	.000170	.000006	.000000	.000523	.000004	.000269
	RANDOM	.000005	.000006	.032074	.294307	.227804	.000102	.001491	.006797	.005087	.003038
8	BIAS			.000000	.030509	.001848	.000006	.000000	.000632	.000040	.000295
	RANDOM	.000005	.000006	.028849	.420159	.916999	.000114	.001033	.009470	.020448	.003965
9	BIAS			.000000	.034110	.002706	.000007	.000000	.000711	.000059	.000312
	RANDOM	.000005	.000006	.019980	.435740	1.435578	.000102	.000618	.009692	.031913	.003849
10	BIAS			.000000	.042422	.001547	.000006	.000000	.000750	.000028	.000352
	RANDOM	.000001	.000002	.016072	.585429	4.127723	.000113	.000458	.010724	.075493	.004874
11	BIAS			.000000	.048258	.006862	.000005	.000000	.000598	.000084	.000383
	RANDOM	.000000	.000000	.007421	.479108	7.119745	.000068	.000220	.005036	.076111	.003679
12	BIAS			.000000	.053264	.080755	.000004	.000000	.000582	.000773	.000402
	RANDOM	.000000	.000000	.004951	.514894	9.744292	.000055	.000127	.004796	.090244	.003603
13	BIAS			.000000	.057891	.129768	.000004	.000000	.000589	.001137	.000420
	RANDOM	.000000	.000000	.003393	.507768	5.350929	.000045	.000082	.004465	.047358	.003371
14	BIAS			.000000	.054471	.069421	.000003	.000000	.000463	.000515	.000409
	RANDOM	.000000	.000000	.002145	.332875	1.979405	.000028	.000057	.001449	.008518	.002559
15	BIAS			.000000	.049219	.072894	.000003	.000000	.000360	.000417	.000388
	RANDOM	.000000	.000000	.001368	.204820	1.625937	.000017	.000043	.000386	.003247	.001913

PROBLEM 1

INDIVIDUAL SUMS
ASCENT RATE = 500.0 M/MIN

UNITS ARE (M/SEC)**2

LINE		REXL	REYL	BEXS**2 REXS	BELXE**2 RELXE	BERXE**2 RERXE	BEXA**2 REXA	BEYS**2 REYS	BELYE**2 RELYE	BERYE**2 RERYE	BEYA**2 REYA
1	BIAS			.000000	.000466	.000000	.000030	.000000	.000407	.000000	.000033
	RANDOM	.018606	.024797	.315456	.001296	.000000	.000084	.311564	.001131	.000000	.000022
2	BIAS			.000000	.000715	.000000	.000018	.000000	.000282	.000000	.000044
	RANDOM	.000744	.000992	.070634	.003928	.000014	.000111	.080784	.001666	.000006	.000212
3	BIAS			.000000	.001689	.000000	.000013	.000000	.000294	.000000	.000075
	RANDOM	.000151	.000201	.027673	.009608	.000005	.000100	.018004	.001765	.000001	.000394
4	BIAS			.000000	.003317	.000000	.000010	.000000	.000283	.000000	.000112
	RANDOM	.000067	.000089	.024593	.025851	.000041	.000114	.010618	.002160	.000003	.000763
5	BIAS			.000000	.006196	.000000	.000007	.000000	.000260	.000000	.000159
	RANDOM	.000030	.000040	.033960	.073979	.000026	.000159	.009649	.003178	.000001	.001707
6	BIAS			.000000	.011793	.000000	.000005	.000000	.000241	.000000	.000226
	RANDOM	.000017	.000022	.023429	.101416	.000054	.000088	.002697	.002303	.000001	.001863
7	BIAS			.000000	.016703	.000000	.000006	.000000	.000344	.000000	.000269
	RANDOM	.000007	.000010	.025718	.194471	.001491	.000104	.001334	.004546	.000034	.003044
8	BIAS			.000000	.020044	.000001	.000006	.000000	.000417	.000000	.000295
	RANDOM	.000007	.000010	.023952	.276777	.004748	.000115	.000921	.006289	.000107	.003270
9	BIAS			.000000	.022354	.000000	.000007	.000000	.000468	.000000	.000312
	RANDOM	.000007	.000010	.016935	.286300	.001308	.000102	.000552	.006411	.000030	.003651
10	BIAS			.000000	.027814	.000035	.000006	.000000	.000492	.000001	.000352
	RANDOM	.000002	.000002	.013914	.384201	.068224	.000114	.000417	.007080	.001253	.004873
11	BIAS			.000000	.031639	.000159	.000005	.000000	.000391	.000002	.000393
	RANDOM	.000000	.000000	.006515	.314206	.279456	.000068	.000210	.003335	.003047	.003677
12	BIAS			.000000	.035122	.000994	.000004	.000000	.000383	.000009	.000403
	RANDOM	.000000	.000000	.004393	.338397	.627700	.000055	.000123	.003181	.005846	.003605
13	BIAS			.000000	.038119	.001422	.000004	.000000	.000388	.000012	.000430
	RANDOM	.000000	.000000	.003045	.333942	.875051	.000045	.000079	.002959	.007681	.003372
14	BIAS			.000000	.035863	.001122	[illegible]	.000000	.000305	.000009	.000408
	RANDOM	.000000	.000000	.001979	.219379	.631356	[illegible]	.000058	.000973	.002767	.002558
15	BIAS			.000000	.032481	.000709	.000003	.000000	.000237	.000004	.000387
	RANDOM	.000000	.000000	.001286	.135611	.368247	.000017	.000044	.000263	.000664	.001912

PROBLEM 1

VARIANCE IN COMPONENTS

LINE	ASCENT RATE, M/MIN = 300.0 EAST VARIANCE (M/SEC)**2	300.0 NORTH VARIANCE (M/SEC)**2	400.0 EAST VARIANCE (M/SEC)**2	400.0 NORTH VARIANCE (M/SEC)**2	500.0 EAST VARIANCE (M/SEC)**2	500.0 NORTH VARIANCE (M/SEC)**2
1	.32902	.30194	.32692	.31480	.33594	.33802
2	.12635	.09634	.09652	.08828	.07616	.08399
3	.08045	.02793	.05499	.02354	.03924	.02072
4	.12085	.01933	.07791	.01600	.05399	.01403
5	.48764	.02994	.16762	.01715	.11436	.01499
6	2.17912	.05073	.20120	.00870	.13680	.00735
7	9.42991	.21565	.57987	.01722	.23850	.00958
8	7.21609	.16536	1.39849	.03589	.32565	.01201
9	351.78196	7.74326	1.92823	.04706	.32701	.01163
10	457.77105	8.34502	4.77331	.09268	.49431	.01447
11	534.83798	5.69128	7.66147	.08611	.63205	.01104
12	678.24055	6.29531	10.39822	.10053	1.00656	.01355
13	678.00104	5.94070	6.04930	.05742	1.25163	.01491
14	444.76541	2.02286	2.43831	.01397	.88973	.00708
15	282.19330	.66945	1.95416	.00675	.53835	.00351

PROBLEM 1 COMPONENT VELOCITY VARIANCE

ASCENT RATE, M/MIN =	300.0		400.0		500.0	
LINE	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)
1	1.19046	1.09108	1.21076	1.10035	1.27159	1.12765
2	.42015	.64819	.34864	.59047	.30216	.54969
3	.20448	.45220	.14822	.38499	.11314	.33636
4	.26448	.51427	.17718	.42093	.12834	.35825
5	.97655	.98820	.34861	.59043	.24405	.49402
6	4.20714	2.05113	.39603	.62931	.27198	.52152
7	18.19864	4.26599	1.12654	1.06139	.46806	.68415
8	13.92685	3.73187	2.70630	1.64508	.63708	.79817
9	678.32971	26.04476	3.72684	1.93050	.63894	.79933
10	879.43867	29.65533	9.18085	3.02999	.95994	.97977
11	1019.83685	31.93488	14.61765	3.82330	1.21334	1.10152
12	1291.53949	35.93799	19.80838	4.45066	1.92469	1.38733
13	1290.41855	35.92240	11.52177	3.39437	2.38963	1.54584
14	842.97221	29.03398	4.62681	2.15130	1.69204	1.30078
15	533.68775	23.10168	3.69972	1.92347	1.02236	1.01112

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***** PROGRAM NAVAID *****

EXAMPLE NAVAID RUN FOR 15 ZONES AND 3 ASCENT RATES
USE INPUT FILES AR, ZNHE, UV, WF
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ARRAY W
(1/METER)

LINE	W0	ZONE 1 11	2 12	3 13	4 14	5 15	6	7	8	9	10
1	-.500-002	.500-002 .000	.000 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
2	-.100-002	-.167-002 .000	.267-002 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
3	-.450-003	-.183-003 .000	-.807-003 .000	.144-002 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
4	-.300-003	-.100-003 .000	-.120-003 .000	-.600-003 .000	.112-002 .000	.000 .000	.000	.000	.000	.000	.000
5	-.200-003	-.667-004 .000	-.333-004 .000	-.100-003 .000	-.660-003 .000	.106-002 .000	.000	.000	.000	.000	.000
6	-.150-003	-.167-004 .000	.667-005 .000	-.200-004 .000	-.600-004 .000	-.390-003 .000	.630-003	.000	.000	.000	.000
7	-.100-003	.000 .000	-.400-004 .000	.000 .000	-.200-004 .000	-.400-004 .000	-.330-003	.530-003	.000	.000	.000
8	-.100-003	.333-004 .000	-.533-004 .000	.000 .000	.000 .000	-.200-004 .000	-.500-004	-.260-003	.450-003	.000	.000
9	-.100-003	.333-004 .000	-.333-004 .000	.000 .000	.000 .000	-.200-004 .000	-.100-004	-.700-004	-.160-003	.360-003	.000
10	-.500-004	-.167-004 .000	.267-004 .000	-.400-004 .000	.200-004 .000	-.100-004 .000	-.100-004	-.100-004	.000	-.195-003	.275-003
11	.000	.000 .190-003	-.200-004 .000	-.600-004 .000	.200-004 .000	-.200-004 .000	.000	-.100-004	.000	-.100-004	-.900-004
12	.000	-.333-004 -.700-004	.133-004 .150-003	-.200-004 .000	-.400-004 .000	.100-004 .000	.000	.000	-.100-004	-.500-005	.500-005
13	.000	-.333-004 .500-005	.133-004 -.550-004	.000 .120-003	-.400-004 .000	-.100-004 .000	.000	.000	.000	-.500-005	.500-005
14	.000	-.333-004 .000	.133-004 .150-004	.000 -.400-004	-.200-004 .900-004	-.300-004 .000	.000	.000	.000	.500-005	.000
15	.000	-.333-004 .500-005	.133-004 .500-005	.000 .100-004	-.200-004 -.300-004	-.300-004 .700-004	.000	.000	.000	.100-004	.000

ARRAY WU
(1/SEC)

LINE	ZONE 1 11	2 12	3 13	4 14	5 15	6	7	8	9	10
1	-.414-001 .000	.000 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
2	.264-001 .000	-.347-001 .000	.000 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
3	.452-002 .000	.180-001 .000	-.262-001 .000	.000 .000	.000 .000	.000	.000	.000	.000	.000
4	.272-002 .000	.426-002 .000	.170-001 .000	-.265-001 .000	.000 .000	.000	.000	.000	.000	.000
5	.182-002 .000	.199-002 .000	.400-002 .000	.209-001 .000	-.303-001 .000	.000	.000	.000	.000	.000
6	.928-003 .000	.744-003 .000	.135-002 .000	.261-002 .000	.138-001 .000	-.207-001	.000	.000	.000	.000
7	.474-003 .000	.125-002 .000	.763-003 .000	.127-002 .000	.198-002 .000	.124-001	-.190-001	.000	.000	.000
8	.400-004 .000	.132-002 .000	.654-003 .000	.595-003 .000	.116-002 .000	.220-002	.992-002	-.167-001	.000	.000
9	.400-004 .000	.953-003 .000	.545-003 .000	.496-003 .000	.108-002 .000	.712-003	.278-002	.629-002	-.137-001	.000
10	.454-003 .000	-.140-003 .000	.116-002 .000	-.176-003 .000	.580-003 .000	.564-003	.481-003	.873-004	.725-002	-.107-001
11	.000 -.768-002	.364-003 .000	.153-002 .000	-.176-003 .000	.908-003 .000	.236-003	.481-003	.873-004	.453-003	.390-002
12	.434-003 .320-002	-.698-004 -.643-002	.582-003 .000	.134-002 .000	.780-005 .000	.206-003	.959-004	.449-003	.252-003	-.661-004
13	.434-003 -.416-004	-.698-004 .253-002	.109-003 -.532-002	.124-002 .000	.580-003 .000	.206-003	.959-004	.679-004	.245-003	-.821-004
14	.434-003 .161-003	-.698-004 -.573-003	.109-003 .133-002	.672-003 -.355-002	.115-002 .000	.206-003	.959-004	.679-004	-.144-003	.104-003
15	.434-003 -.663-004	-.698-004 -.144-003	.109-003 -.640-003	.672-003 .724-003	.115-002 -.230-002	.206-003	.959-004	.679-004	-.338-003	.960-004

ARRAY WV
(1/SEC)

LINE	ZONE 1 / 11	2 / 12	3 / 13	4 / 14	5 / 15	6	7	8	9	10
1	-.370-001	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
2	.124-001	-.198-001	.000	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
3	.138-002	.460-002	-.970-002	.000	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
4	.752-003	.387-003	.232-002	-.568-002	.000	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
5	.501-003	-.433-004	.900-004	.211-002	-.413-002	.000	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
6	.128-003	-.205-003	-.121-003	.234-004	.114-002	-.207-002	.000	.000	.000	.000
	.000	.000	.000	.000	.000					
7	.300-005	.161-003	-.195-003	-.858-004	.340-004	.172-002	-.237-002	.000	.000	.000
	.000	.000	.000	.000	.000					
8	-.245-003	.280-003	-.167-003	-.140-003	-.740-005	.391-003	.138-002	-.223-002	.000	.000
	.000	.000	.000	.000	.000					
9	-.245-003	.151-003	-.139-003	-.117-003	.480-005	.188-003	.408-003	.896-003	-.189-002	.000
	.000	.000	.000	.000	.000					
10	.125-003	-.237-003	.147-003	-.172-003	-.370-005	.128-003	.871-004	.261-004	.835-003	-.131-002
	.000	.000	.000	.000	.000					
11	.000	.129-003	.276-003	-.172-003	.292-004	.952-004	.871-004	.261-004	.340-005	.135-003
	-.610-003	.000	.000	.000	.000					
12	.248-003	-.118-003	.776-004	.109-003	-.817-004	.833-004	.329-004	.727-004	-.155-004	-.147-003
	.222-003	-.478-003	.000	.000	.000					
13	.248-003	-.118-003	-.278-004	.133-003	-.370-005	.833-004	.329-004	.203-004	-.106-004	-.132-003
	-.173-004	.195-003	-.402-003	.000	.000					
14	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.580-004	-.100-003
	-.130-005	-.399-004	-.478-004	-.120-003	.000					
15	.248-003	-.118-003	-.278-004	.546-004	.743-004	.833-004	.329-004	.203-004	-.816-004	-.934-004
	-.171-004	-.795-005	-.114-003	-.106-003	.532-004					

PROBLEM 1

WIND ERROR INPUT
ASSUMED ONE SIGMA ERRORS

EXAMPLE NAVAID PROBLEM

```
EAST TRACKING ERROR  (METERS) =  100.00
NORTH TRACKING ERROR (METERS) =  100.00
RANDOM LAUNCH ERROR  (METERS) =    5.00
```

PROBLEM 1

INDIVIDUAL SUMS
ASCENT,RATE = 300.0 M/MIN

UNITS ARE (M/SEC)**2

LINE	REXL	REYL	REXZ**2	REXZ	REXX	REYZ**2	REYZ	REYY
1	.028646	.028646	.002468	.002468	.156250	.001971	.001971	.156250
2	.001146	.001146	.000180	.003044	.061826	.000118	.000885	.061806
3	.000232	.000232	.000028	.001738	.017237	.000020	.000185	.017237
4	.000103	.000103	.000077	.002111	.010242	.000017	.000083	.010242
5	.000046	.000046	.000053	.003375	.009842	.000008	.000054	.009842
6	.000026	.000026	.000054	.001894	.002218	.000005	.000017	.002218
7	.000011	.000011	.000124	.002255	.001241	.000005	.000037	.001241
8	.000011	.000011	.000080	.002108	.000879	.000004	.000039	.000879
9	.000011	.000011	.000102	.001645	.000517	.000005	.000032	.000517
10	.000003	.000003	.000118	.001630	.000363	.000003	.000024	.000363
11	.000000	.000000	.000154	.001158	.000169	.000002	.000007	.000169
12	.000000	.000000	.000225	.001299	.000107	.000002	.000007	.000107
13	.000000	.000000	.000193	.001163	.000073	.000002	.000007	.000073
14	.000000	.000000	.000252	.000728	.000047	.000002	.000001	.000047
15	.000000	.000000	.000228	.000412	.000035	.000001	.000002	.000035

PROBLEM 1

INDIVIDUAL SUMS
ASCENT,RATE = 400.0 M/MIN

UNITS ARE (M/SEC)**2

LINE	REXL	REYL	REXZ**2	REXZ	REXX	REYZ**2	REYZ	REYY
1	.050926	.050926	.002468	.002468	.370370	.001971	.001971	.370370
2	.002037	.002037	.000180	.003044	.146502	.000118	.000685	.146502
3	.000412	.000412	.000028	.001738	.040858	.000020	.000185	.040858
4	.000183	.000183	.000077	.002111	.024279	.000017	.000083	.024279
5	.000081	.000081	.000053	.003375	.023330	.000008	.000054	.023330
6	.000046	.000046	.000054	.001894	.005257	.000005	.000017	.005257
7	.000020	.000020	.000124	.002255	.002941	.000005	.000037	.002941
8	.000020	.000020	.000080	.002108	.002084	.000004	.000039	.002084
9	.000020	.000020	.000102	.001645	.001226	.000005	.000032	.001224
10	.000005	.000005	.000118	.001630	.000861	.000003	.000024	.000861
11	.000000	.000000	.000154	.001158	.000400	.000002	.000007	.000400
12	.000000	.000000	.000225	.001299	.000254	.000002	.000007	.000254
13	.000000	.000000	.000193	.001163	.000174	.000002	.000007	.000174
14	.000000	.000000	.000252	.000728	.000112	.000002	.000001	.000112
15	.000000	.000000	.000228	.000412	.000083	.000001	.000002	.000083

PROBLEM 1

INDIVIDUAL SUMS
ASCENT.RATE = 500.0 M/MIN

UNITS ARE (M/SEC)**2

LINE	REXL	REYL	REXZ**2	REXZ	REXX	REYZ**2	REYZ	REYY
1	.079572	.079572	.002468	.002468	.723380	.001971	.001971	.723380
2	.003183	.003183	.000180	.003044	.286137	.000118	.000885	.286137
3	.000645	.000645	.000028	.001738	.079801	.000020	.000185	.079801
4	.000286	.000286	.000077	.002111	.047419	.000017	.000083	.047419
5	.000127	.000127	.000053	.003375	.045566	.000008	.000054	.045566
6	.000072	.000072	.000054	.001894	.010268	.000005	.000017	.010268
7	.000032	.000032	.000124	.002255	.005744	.000005	.000037	.005744
8	.000032	.000032	.000080	.002108	.004070	.000004	.000039	.004070
9	.000032	.000032	.000102	.001645	.002394	.000005	.000032	.002394
10	.000008	.000008	.000118	.001630	.001682	.000003	.000024	.001682
11	.000000	.000000	.000154	.001158	.000781	.000002	.000007	.000781
12	.000000	.000000	.000225	.001299	.000497	.000002	.000007	.000497
13	.000000	.000000	.000193	.001163	.000340	.000002	.000007	.000340
14	.000000	.000000	.000252	.000728	.000219	.000002	.000001	.000219
15	.000000	.000000	.000228	.000412	.000162	.000001	.000002	.000162

PROBLEM 1 VARIANCE IN COMPONENTS

ASCENT RATE (M/MIN) = 300.0 400.0 500.0

LINE	300.0 EAST VARIANCE (M/SEC)**2	300.0 NORTH VARIANCE (M/SEC)**2	400.0 EAST VARIANCE (M/SEC)**2	400.0 NORTH VARIANCE (M/SEC)**2	500.0 EAST VARIANCE (M/SEC)**2	500.0 NORTH VARIANCE (M/SEC)**2
1	.18983	.18884	.42623	.42524	.80789	.80689
2	.06618	.06395	.15176	.14954	.29254	.29032
3	.01923	.01767	.04304	.04148	.08221	.08065
4	.01253	.01045	.02665	.02456	.04989	.04780
5	.01332	.00995	.02654	.02347	.04912	.04576
6	.00419	.00227	.00725	.00533	.01229	.01036
7	.00363	.00129	.00534	.00300	.00815	.00582
8	.00308	.00093	.00429	.00215	.00629	.00414
9	.00227	.00056	.00299	.00128	.00417	.00246
10	.0021[illegible]	.00039	.00261	.00089	.00344	.00172
11	.00148	.00018	.00171	.00041	.00209	.00079
12	.00163	.00012	.00178	.00026	.00202	.00051
13	.00143	.00008	.00153	.00018	.00170	.00035
14	.00103	.00005	.00109	.00011	.00120	.00022
15	.00068	.00004	.00072	.00009	.00080	.00017

PROBLEM 1

COMPONENT VELOCITY VARIANCE

ASCENT RATE (M/MIN) =	300.0		400.0		500.0	
LINE	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)	VARIANCE (KNOT**2)	STANDARD DEVIATION (KNOT)
1	.71445	.84525	1.60650	1.26748	3.04667	1.74547
2	.24552	.49550	.56848	.75398	1.09972	1.04867
3	.06964	.26389	.15945	.39931	.30728	.55433
4	.04336	.20822	.09662	.31084	.18433	.42934
5	.04390	.20951	.09493	.30810	.17901	.42309
6	.01218	.11038	.02373	.15404	.04273	.20672
7	.00929	.09640	.01574	.12547	.02636	.16236
8	.00757	.08701	.01215	.11023	.01969	.14031
9	.00536	.07320	.00807	.08981	.01252	.11187
10	.00473	.06878	.00662	.08135	.00972	.09861
11	.00313	.05593	.00400	.06325	.00544	.07375
12	.00330	.05743	.00385	.06207	.00477	.06904
13	.00285	.05340	.00323	.05685	.00386	.06210
14	.00203	.04509	.00228	.04772	.00268	.05177
15	.00135	.03668	.00153	.03908	.00183	.04273